ALTERNATIVE FUEL FUELING FACILITIES STUDY
FINAL REPORT

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EXECUTIVE SUMMARY

Senate Bill 1759 of the 81st Texas Legislature directs the Texas Commission on Environmental Quality (TCEQ) to conduct a study to assess the correlation between the installation of alternative fuel fueling facilities in nonattainment areas and the deployment of fleet vehicles that use alternative fuels and to determine the emission reductions achieved from replacing a diesel-powered engine with an engine utilizing alternative fuels. In addition, the bill also requires the TCEQ to determine the amount of emission reductions that are fairly attributable to the installation of an alternative fuel fueling facility and the combustion of the alternative fuel being used in the vehicles fueled by the facility.

This report finds that alternative fuel use in the Texas nonattainment areas is dominated by three fuels: compressed natural gas (CNG), liquefied natural gas (LNG), and propane (LPG). Dallas-Fort Worth (DFW) has the highest level of alternative fuel consumption for all three major fuels. About 90 percent of the alternative fuel use is in the DFW area. LNG is the most prevalent fuel used, and almost all of that consumption is by Dallas Area Rapid Transit (DART) transit buses. CNG consumption was the next largest portion of total alternative fuel consumption, and this is more diffuse across the three ozone nonattainment areas, and across different consumers. LPG fuel consumption is primarily by school buses, although there is some LPG use by light-duty vehicles. Table ES-1 summarizes 2009 alternative fuel consumption in the three study areas.

Table ES-1. Total 2009 Alternative Fuel Consumption in Texas Ozone Nonattainment Areas (Gasoline Gallon Equivalent)

	DFW	Houston-Galveston-Brazoria (HGB)	Beaumont-Port Arthur (BPA)	All Ozone Nonattainment Areas
LPG	2,175,418	404,090	46,479	2,625,987
CNG	2,696,709	105,676	240,000*	3,042,385
LNG	4,669,064	156,056	0	4,825,120
Total	**9,541,191**	**665,822**	**286,479**	**10,493,492**

*This is based on an estimate for FY 2010. BPA acquired their CNG fleet in summer 2009, and therefore 2009 CNG consumption would be much lower.

This analysis also examines how alternative fuel usage in the three study areas and resulting emissions might be different in 2018 than it was during 2009. Potential shifts in alternative fuel use include:

1. Increased use of CNG by buses in the DFW area;
2. Increased propane usage in Texas school buses; and
3. Increased heavy-duty truck usage of LNG.

None of these potential shifts is likely to produce significant changes in alternative fuel volumes or associated criteria air pollutant (CAP) emissions in the Texas ozone nonattainment areas.

Table ES-2 summarizes the estimated 2010 criteria pollutant emission benefits of the alternative fuels being used currently in Texas by area. This table shows that motor vehicle alternative fuel use in Texas ozone nonattainment areas provides estimated emission reductions of about 0.5 tons per day (tpd) for oxides of nitrogen (NO_x), 0.03 tpd for PM_{10}, and 0.02 tpd for $PM_{2.5}$. Emissions of carbon monoxide (CO) volatile organic compounds (VOCs) are expected to increase. Most of the NO_x and particulate emission benefits are observed in the DFW metropolitan area. The vehicle type that provides the largest observed alternative fuel emission benefit currently is transit buses.

Table ES-2. Alternative Motor Vehicle Fuel Emission Reductions (2010) (tpd)

	Pollutant				
Area	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
DFW	-.011	-.057	0.488	0.022	0.021
HGB	-0.004	-0.032	0.039	0.003	0.003
BPA	0.000	-0.004	0.003	0.000	0.000
Totals	**-0.015**	**-0.093**	**0.531**	**0.026**	**0.024**

An analysis of the expected alternative fuel emission reductions for 2018 showed that alternative fuel benefits in that year will be near zero because the most recent Federal emission standards for criteria pollutants require emission controls to the extent that inter-fuel emission differences are not observable. However, there is very limited measurement data for the newest technologies using alternative fuels, and it is recommended that TCEQ evaluate such data as it becomes available so that motor vehicle fleets can better understand the criteria pollutant benefits of using alternative fuels in modern technology vehicles. There is also limited emissions test data for existing vehicle technologies comparing alternative fuel emission rates with emission rates when using conventional diesel fuel.

Because transit buses have a large fraction of the alternative fuel use in Texas nonattainment areas, their emission benefits or disbenefits estimates have a significant effect on the overall study findings. All of the CNG and LPG emission test results for buses meeting U.S. Federal standards is based on tests on 1998, 1999, and 2001 model year buses. These buses emissions performance may not be representative of those of later model years (2002 through 2006), although this study uses these data as a best estimate of emission differences for those model years. This assumption may overstate the benefits of alternative fuel use.

CHAPTER I. INTRODUCTION

Senate Bill 1759, Acts of the Texas Legislature, directs the Texas Commission on Environmental Quality (TCEQ) to conduct a study to assess the correlation between the installation of alternative fuel stations in ozone nonattainment areas and the deployment of fleet vehicles that use alternative fuels and to determine the emission reductions achieved from replacing a diesel-powered engine with an engine using alternative fuels. In addition, the bill also requires the TCEQ to determine the amount of emission reductions that are fairly attributable to the installation of an alternative fuel station and the combustion of alternative fuel being used in the vehicles fueled by the facility. This TCEQ-sponsored study provides estimates of the criteria air pollutant (CAP) emission reduction benefits of alternative fuel use during calendar year 2009 in the Beaumont-Port Arthur (BPA), Dallas/Fort Worth (DFW), and Houston-Galveston-Brazoria (HGB) ozone nonattainment areas. It also includes estimates of the expected alternative fuel benefits in these areas in 2018.

For the purpose of this project, alternative fuels are defined as electricity, compressed natural gas (CNG), liquefied natural gas (LNG), hydrogen, propane, methanol, or a mixture of fuels containing at least 85 percent methanol by volume. Criteria pollutants are defined as volatile organic compounds (VOC), oxides of nitrogen (NO_x), carbon monoxide (CO), and particulate matter (PM).

Chapter II examines available models and data sets that provide information about motor vehicle emission rates when alternative fuels are burned compared with conventional diesel and gasoline emission rates. This chapter describes the data sources and methods that were used for estimating reductions in onroad diesel vehicle emission rates in 2009 and 2018 associated with alternative fuel use in motor vehicles.

Chapter III of this report provides the findings of Task 3 of the subject study, which is an alternative fuel fueling facility and fleet identification report. This chapter provides the identity, location, and age of each public and privately-owned alternative fuel station located in counties BPA, DFW, and HGB ozone nonattainment areas, the identity of each fleet being serviced by each facility, the date on which each fleet began to use the facility, and the number of alternative fueled fleet vehicles that each fleet is having fueled at the facility. This chapter also lists the model year, make, weight classification, fuel type, and the annual mileage and annual fuel usage of each alternative fueled fleet vehicle operated by each fleet that is being fueled at each identified alternative fueling facility.

Chapter IV uses the data collected in Task 3 and the emission reduction potential of each alternative fuel determined in Task 2 to estimate the emission benefit in tons per day (tpd) of reduced criteria pollutants in 2010 and 2018 that are attributable to motor vehicle use of alternative fuels. This analysis is presented by nonattainment area, fuel type, and pollutant. This chapter also provides an analysis of the estimated emission reduction benefit for each criteria pollutant that is fairly attributable to the installation of an alternative fuel fueling facility located in the ozone nonattainment areas. Chapter IV also examines whether the data reported in Chapter III determines a correlation between the installation of alternative fuel fueling facilities and the deployment of alternative fueled fleet vehicles.

Chapter V provides recommendations for new research that could improve future alternative fuel emissions assessments.

CHAPTER II. EMISSION CHARACTERISTICS OF MOTOR VEHICLES USING ALTERNATIVE FUELS

This chapter discusses the data sources and methodologies that are used for estimating reductions in onroad diesel vehicle emission rates in 2010 and 2018 that might be achieved with the use of alternative fuels. Based on the predominant alternative fueling stations in the Texas nonattainment areas, this chapter focuses on the following alternative fuels: CNG, LNG, and propane (LPG). Criteria pollutants evaluated are VOCs, NO_x, CO, and PM.

The evaluation of emission reductions included the following subtasks: 1) determine the availability of alternative fueled vehicles in Texas; 2) estimate baseline diesel emission rates; 3) estimate the emission rates of comparable alternative fueled vehicles; and 4) estimate the emission reductions from alternative fuel vehicles compared to diesel vehicles on a grams per gallon (g/gal) basis in 2010 and 2018.

Pechan first evaluated combinations of fuel and vehicle weight categories available in Texas. Based on the fueling station data for Texas, CNG, LNG, and LPG were determined to be the most widespread alternate fuels available in Texas for fleet vehicles that could be used to replace diesel fueled vehicles. Pechan then evaluated technologies available using these fuels. In order for a combination of fuel and vehicle type to be technologically feasible, the fuel/weight category combination should be available for sale in Texas, or available via retrofit.

For the three primary alternative fuels (CNG, LNG, and LPG), we found evidence of the availability of vehicles using these fuels, whether original manufactured vehicles or conversions, in all weight categories. Much of the information available on alternative fuels was found through the U.S. Department of Energy's Alternative Fuels and Advanced Vehicles Data Center (AFDC).

The baseline emission rates for diesel vehicles were estimated using the U.S. Environmental Protection Agency's (EPA's) MOBILE6.2 mobile source emission factor model. We had initially planned to use EPA's latest onroad vehicle emission model, known as the Motor Vehicle Emission Simulator (MOVES2010) for calculating the baseline diesel emission factors. However, upon review of the emission factors by model year, several inexplicable trends in the diesel emission rates on a grams per mile basis were observed. For example, the NO_x emission rate for light-duty diesel vehicles for the 2002 model year was 0.946 grams per mile (g/mi) while the comparable 2003 model year emission rate was 3.49 g/mi. EPA was unable to provide an explanation or correction during the time of this project. Therefore, to prevent anomalous results from occurring in this study, MOBILE6.2 was used to estimate the baseline diesel and gasoline emission rates by model year. These emission rates were estimated based on conditions typical in the Texas nonattainment areas. Emission rates in g/mi were calculated for each model year from 1993 through 2018, based on a calendar year of 2010 and 2018 (e.g., the emission rate of a 1993 model year vehicle in 2010). Emission factors were developed for 13 vehicle weight categories. While MOBILE6 does not produce emission rates in g/gal, the model estimates the corresponding fuel economy in miles per gallon (mpg) for each vehicle type and model year. The g/mi emission rates were multiplied by the corresponding fuel economy to obtain a g/gal emission rate.

Note that some of the data on emission reductions achieved by alternate fuels, particularly for the lighter vehicle types, is based on reductions from gasoline rather than diesel. Therefore, we also estimated emissions for gasoline vehicles in a manner comparable to that used for the diesel emission baseline. As with the diesel vehicles, the gasoline emission factors were estimated using MOBILE6 to produce g/mi emission rates which were then converted to g/gal emission factors.

The preferred approach to estimating alternative fuel emission factors would be to use the MOVES model. However, at this time, the model only has the capability to estimate CNG emissions from transit buses. Therefore, the MOVES model was used to estimate the CNG percentage reductions from comparable diesel emission rates.

To estimate emission rates for the other alternative fuel/vehicle combinations, we performed a literature search for studies documenting emission reductions based on the use of these alternative fuels. Again, much of the emission testing work in this area is summarized by AFDC with links to the actual reports. A large number of the available studies on emission reductions from alternative fuels have been prepared or sponsored by the National Renewable Energy Laboratory (NREL). The next section summarizes the data found on emission reductions that was used to estimate emission rates of alternative fuel vehicles in comparison to diesel vehicles.

Due to the tightened emission standards of the Tier 2 program for light-duty vehicles and the emission standards for heavy-duty vehicles for 2007 and later model years, emission differences between conventionally-fueled vehicles and alternative-fueled vehicles become negligible as all vehicles must be certified to meet the same emission standards regardless of fuel type. For the criteria pollutants other than evaporative VOC, based on information from EPA, Argonne National Laboratory, and the California Energy Commission, we have assumed that there is no reduction in emissions relative to a baseline gasoline or diesel vehicle.

The emission reduction percentages shown in the tables in Section A were applied to the baseline gasoline or diesel g/mi emission rates, depending upon the baseline used to estimate the emission reductions in the literature. This resulted in g/mi alternative fuel emission rates. G/gal emission rates were also calculated by multiplying the baseline gasoline or diesel emission rates by the ratio of the gallons of alternative fuel to the equivalent gallons of the baseline fuel, based on the energy content of a gallon of fuel, and then applying the percentage reduction.

A. EMISSION REDUCTION DATA FOR ALTERNATIVE FUELS

This section provides summary information from the literature reviewed in determining potential emission reductions of LPG, CNG, and LNG alternative fuels. While vehicles have been using alternative fuels for a number of years, data on criteria air pollutant emission reductions attributable to alternative fuels are still limited.

1. LPG

Propane vehicles available in the U.S. are primarily available as conversions. However, LPG vehicle applications are currently being used throughout the U.S. in all weights and categories of vehicles. The AFDC notes that manufactured propane vehicles are generally cleaner-burning than conversions because the systems can be optimized. Additionally, LPG conversions may emit more emissions than manufactured LPG vehicles if the conversion is not properly designed and installed. Reports of emission reductions from LPG vehicles may also be contradictory as propane engines can be calibrated to choose between the pollutants to be optimized; thus, a rich calibration will reduce NO_x emissions but increase CO and hydrocarbon emissions while a lean calibration will produce opposite results (AFDC, 2010).

Table II-1 summarizes the LPG emission reductions used in this analysis for pre-Tier 2 light-duty vehicles and pre-2005 heavy-duty vehicles. The data for light-duty vehicles and trucks are based on data from an Argonne National Laboratory report, as summarized by AFDC. The emission reductions for these vehicles are based on reductions from a vehicle running on reformulated gasoline. The LPG vehicles represented by these reductions are converted vehicles.

The emission reductions applied to the remaining vehicle types are based on reductions reported by the United Parcel Service (UPS) when adding 139 new propane delivery trucks to its North American delivery service in 2007 (AFDC, 2007). These reductions are relative to gasoline fueled vehicles. As no additional information was found for the heavy-heavy duty applications or buses, these reduction percentages were applied to all of the heavy duty vehicle categories.

For both heavy and light-duty vehicles from more recent model years (Tier 2 light-duty vehicles and 2007+ heavy-duty vehicles), we have assumed that there is no significant difference in exhaust VOC, CO, NO_x, or PM emission rates between conventional vehicles and LPG vehicles of the same model year (ANL, 2007; CEC, 2007; EPA, 2010) For evaporative VOC from light-duty vehicles, emissions are reduced by 20 percent from a comparable baseline gasoline vehicle (ANL, 2007).

Table II-1. Emission Reductions from pre-2004 Light-Duty Vehicles and pre-2007 Heavy-Duty Vehicles Operating on LPG

Description	Percentage Reduction in g/mi Emission Rate				Notes on Baseline and Data Source
	VOC	NO_x	CO	PM	
Light-Duty Vehicles (Passenger Cars)	-	-	30%	80%	Reductions based on emissions of Converted Propane and Reformulated Gasoline LDVs Data Sources: AFDC, 2010 and ANL, 1999.
Light-Duty Trucks 1 and 2 (0-6,000 pounds [lbs] gross vehicle weight rating [GVWR])					
Light-Duty Trucks 3 and 4 (6,001-8,500 lbs GVWR)					
Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs GVWR)	30%	20%	60%	-	Reductions based on gasoline-fueled vehicles. Data Source: http://www.afdc.energy.gov/afdc/ vehicles/emissions_propane.html
Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs GVWR)					
Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs GVWR)					
Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs GVWR)					
Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs GVWR)					
Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs GVWR)					
Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs GVWR)					
Class 8b Heavy-Duty Vehicles (>60,000 lbs GVWR)					
Transit and Urban Buses					
School Buses					

2. CNG

CNG vehicles are available and commonly used in both light and heavy duty applications. CNG vehicles can be either dedicated vehicles, which are designed to run only on natural gas, or bi-fuel vehicles that have two separate fueling systems that allow the vehicle to be fueled either with CNG or conventional gasoline or diesel fuel. Better performance and lower emissions are generally achieved with dedicated CNG vehicles than with bi-fuel vehicles.

Table II-2 summarizes the emission reduction percentages applied to CNG vehicles in this study, along with the baseline to which these reductions should be applied and the source of the data. As shown in the table, the light duty reductions are from a reformulated gasoline baseline. The data were based on a study performed by the NREL of a CNG cab fleet (NREL, 1999). Emission tests were performed on 10 reformulated gasoline-fueled and 10 CNG-fueled cabs at roughly 60,000 odometer miles, 90,000 miles, and 120,000 miles. Uses of these cabs were relatively comparable regardless of fuel type. All vehicles were 1996 model year. Results of the average of the exhaust emission tests for each of the three rounds of testing were reported separately for the gasoline vehicles and the CNG vehicles, as shown in the Table II-3. The mid-point of the range of these three values was used to estimate the reduction from gasoline to CNG in nonmethane hydrocarbon (NMHC), CO, and NO_x. Note that this results in a slight increase in NO_x emissions. The resulting emission reductions (or increase) were applied to light duty cars and trucks, as shown in Table II-2.

Table II-2. Emission Reductions from pre-2004 Light-Duty Vehicles and pre-2007 Heavy-Duty Vehicles Operating on CNG

Description	Percentage Reduction in g/mi Emission Rate				Notes on Baseline
	VOC	NO_x	CO	PM	
Light-Duty Vehicles (Passenger Cars) Light-Duty Trucks 1 and 2 (0-6,000 lbs GVWR) Light-Duty Trucks 3 and 4 (6,001-8,500 lbs GVWR)	68%	-0.6%	61%	-	Based on comparison of dedicated CNG and gasoline cabs (g/mile). The gasoline used was California Phase II reformulated gasoline (RFG), which was selected to represent the "best case" gasoline fuel. Data Source: NREL, 1999
Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs GVWR)	94%	83%	94%	-	Based on FTP-75 comparison of dedicated CNG and (RFG) gasoline (g/mile) Data Source: NREL, 2000a.
Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs GVWR) Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs GVWR) Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs GVWR)	4%	49%	75%	95%	Based on comparison of 1996 diesel and 1997 CNG vehicles. Data Source: NREL, 2002
Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs GVWR) Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs GVWR) Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs GVWR) Class 8b Heavy-Duty Vehicles (>60,000 lbs GVWR)	-	35%	90%	90%	Based on emission testing of natural gas and diesel vehicles. Data Source: NREL, 2003.
Transit and Urban Buses School Buses	-	62%	-	97%	Based on MOVES default emission comparison of natural gas and diesel transit buses

Table II-3. Light-Duty Vehicle 1996 Model Year Regulated Exhaust Emissions (g/mi)

	Test Round (miles)	CNG	Reformulated Gasoline	Percentage Reduction
NMHC	60,000	0.049	0.125	-60.8%
	90,000	0.055	0.172	-68.0%
	120,000	0.045	0.177	-74.6%
CO	60,000	0.928	2.764	-66.4%
	90,000	1.257	3.703	-66.1%
	120,000	2.043	4.622	-55.8%
NO_x	60,000	0.243	0.263	-7.6%
	90,000	0.295	0.269	9.7%
	120,000	0.309	0.338	-8.6%

SOURCE: NREL, 1999.

Emission reductions for the HDDV2B category were based on an NREL study of SuperShuttle vans, examining the reductions in emissions from dedicated CNG vans compared to gasoline vans. The emission testing was performed at approximately 10,000, 40,000, and 60,000 miles of use. Five dedicated CNG vans and three standard gasoline vans were included in the testing. The vans were all of the same make and model (1999 Ford E350 vans). Table II-4 shows the average emission results from each round of the study. We then used the midpoint of the range of reductions for each pollutant, as shown in Table II-2. These reductions were applied to the Class 2B vehicles.

Table II-4. Model Year 1999 Ford E350 Van Regulated Exhaust Emissions (g/mi)

	Test Round (miles)	Dedicated CNG	Gasoline	Percentage Reduction
NMHC	10,000	0.012	0.298	-96.0%
	40,000	0.022	0.280	-92.1%
	60,000	0.017	0.390	-95.6%
CO	10,000	0.365	6.140	-94.1%
	40,000	0.338	5.873	-94.2%
	60,000	0.500	9.067	-94.5%
NO_x	10,000	0.055	1.443	-96.2%
	40,000	0.560	1.903	-70.6%
	60,000	0.490	2.763	-82.3%

SOURCE: NREL, 2000a.

Emission reductions for the HDV3 through HDV5 categories were based on a study of the UPS CNG truck fleet performed by the Department of Energy/NREL (NREL, 2002). This included testing of seven CNG UPS delivery trucks, all of the 1997 model year, and three diesel UPS delivery trucks, all of the 1996 model year. The VOC reductions reported here are based on hydrocarbon emissions from the diesel trucks compared to NMHC emissions from the CNG trucks, as methane emissions are significant from CNG vehicles. The reductions reported in Table II-2 are those estimated by NREL based on the average emission rates of the tests of the seven CNG trucks and the three diesel trucks.

The HDDV6 through HDDV8 emission reductions were based on an NREL study of a CNG engine applied in two Class 8 tractor trailers versus comparable diesel engines (NREL, 2003). Both sets of trucks were tested over two different test cycles. The estimated emission reductions in Table II-2 represent the average of the reductions achieved by the CNG vehicles relative to the diesel vehicles over the two test cycles. While the tests in this study were performed on Class 8 vehicles, we have also applied these results to the Class 6 and 7 heavy-duty vehicles, as shown in Table II-2.

Finally, the emission reductions for buses are based on EPA's MOVES2010 model. CNG buses are currently the only vehicle category with information available within MOVES to estimate emissions from alternative fuels. These results have also been applied to school buses.

For both heavy and light-duty vehicles from more recent model years (Tier 2 light-duty vehicles and 2007+ heavy-duty vehicles, we have assumed that there is no significant difference in exhaust VOC, CO, NO_x, or PM emission rates between conventional vehicles and CNG vehicles of the same model year (ANL, 2007; CEC, 2007; EPA, 2010). For evaporative VOC from light-duty vehicles, emissions are reduced by 50 percent from a comparable baseline gasoline vehicle (ANL, 2007).

3. LNG

Emission rates for vehicles using LNG are generally comparable to those achieved with CNG. Table II-5 summarizes the emission reductions applied in this study for LNG vehicles. As shown in this table, the reductions estimated for CNG for light-duty vehicles and trucks and heavy duty vehicles, with the exception of buses, are the same as those reported in Table II-2 for the CNG vehicles.

Table II-5. Emission Reductions from pre-2004 Light-Duty Vehicles and pre-2007 Heavy-Duty Vehicles Operating on LNG

Description	Percentage Reduction in g/mi Emission Rate				Notes on Baseline
	VOC	NO_x	CO	PM	
Light-Duty Vehicles (Passenger Cars)					Same as for CNG vehicles of the corresponding weight class.
Light-Duty Trucks 1 and 2 (0-6,000 lbs GVWR)					
Light-Duty Trucks 3 and 4 (6,001-8,500 lbs GVWR)					
Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs GVWR)					
Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs GVWR)					
Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs GVWR)					
Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs GVWR)					
Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs GVWR)					
Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs GVWR)					
Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs GVWR)					
Class 8b Heavy-Duty Vehicles (>60,000 lbs GVWR)					
Transit and Urban Buses	96%	17%	95%	97%	Reductions were based on comparison of LNG and diesel vehicles. Data Source: NREL, 2000b
School Buses					

Data on reductions from buses were obtained from an NREL study of the Dallas Area Rapid Transit's (DART's) LNG bus fleet (NREL, 2000b). The evaluation is of 10 transit buses using LNG compared with five diesel buses. On average, the study showed emission reductions of 95 percent for CO, 17 percent for NO_x, and 96 percent for NMHC. It should be noted that the 96 percent reduction in NMHC is based on a comparison of hydrocarbon emissions from the diesel buses compared to NMHC emissions from the CNG buses. Notably, methane emissions from LNG vehicles are much higher than diesel methane emissions. The emission reduction for PM was too low to be detectable, noted as less than 0.01 g/mi. We estimated the PM reduction from

LNG buses at 97 percent based on a diesel PM emission rate of 0.32 g/mi. Due to a lack of data, these reductions were also applied to school buses operating on LNG.

For both heavy and light-duty vehicles from more recent model years (Tier 2 light-duty vehicles and 2007+ heavy-duty vehicles, it is estimated that there is no significant difference in exhaust VOC, CO, NO_x, or PM emission rates between conventional vehicles and LNG vehicles of the same model year (ANL, 2007; CEC, 2007; EPA, 2010). For evaporative VOC from light-duty vehicles, emissions are reduced by 50 percent from a comparable baseline gasoline vehicle (ANL, 2007).

B. RESULTING DIESEL AND ALTERNATIVE FUEL EMISSION RATES

This section provides sample summary results for two vehicle classes. These results are presented based on emission factors for two vehicles in 2010. Table II-6 presents results for model year 2000 diesel and CNG transit buses while Table II-7 presents diesel and LPG results for a Class 3 heavy-duty vehicle from model year 1997. Due to the lower energy content of the alternative fuels, the g/gal emission factors are typically lower than the corresponding diesel factors, even in cases where there are no emission reductions. Emission reductions for more recent model years will be negligible, based on the assumptions stated earlier in this report that no changes are expected for most pollutants since vehicles of all fuel types are subject to the same stringent emission standards.

Table II-6. Comparison of Diesel and CNG Transit Bus Emission Factors in 2010 for Model Year 2000 Buses

	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$
Baseline Diesel Emission Rate (g/mi)	0.23	3.14	16.75	0.138	0.127
CNG Emission Rate (g/mi)	0.23	3.14	6.37	0.004	0.004
Percentage Reduction	0%	0%	62%	97%	97%
Baseline Diesel Emission Rate (g/gal diesel)	0.985	13.67	73.03	0.600	0.552
CNG Emission Rate (g/gal diesel equivalent)	0.985	13.67	27.75	0.018	0.017

Table II-7. Comparison of Diesel and LPG Class 3 Heavy Duty Vehicle Emission Factors in 2010 for Model Year 1997 Vehicles

	VOC	CO	NO_x	PM_{10}	$PM_{2.5}$
Baseline Diesel Emission Rate (g/mi)	0.24	1.16	5.47	0.092	0.085
LPG Emission Rate (g/mi)	0.17	0.46	4.37	0.092	0.085
Percentage Reduction	30%	60%	20%	0%	0%
Baseline Diesel Emission Rate (g/gal diesel)	2.84	13.5	63.74	1.07	0.99
LPG Emission Rate (g/gal diesel equivalent)	1.99	5.41	51.00	1.07	0.99

C. CAVEATS

The emission tests upon which the emission reductions in this chapter are based generally used vehicles from the 1990s. Thus, the light-duty vehicles would be likely to be meeting the Tier 1 emission standards. These emission standards began to be tightened with the low-emission vehicle emission standards, which were required nationally in the 2001 model year, and 1999 or earlier in the northeast states. Tier 2 emission standards further tightened the light-duty emission standards starting with the 2004 model year. On the heavy-duty vehicle side, the emission standards in place during the 1990s began to be tightened with the 2002 model year, as standards originally scheduled for the 2004 model year began to be implemented due to the heavy duty "pull ahead" agreements. Heavy-duty gasoline emission standards were tightened starting with the 2005 model year. The current set of heavy-duty emission standards began to be phased in during the 2007 model year, with full phase-in by 2010.

Data are not available showing the emission differences between gasoline or diesel vehicle emission rates and emission rates for alternate fuel vehicles when meeting each of these sets of emission standards. As discussed above, this study assumed that the 2007 heavy-duty emission standards and the Tier 2 2004 light-duty emission standards would be the point at which emission rates for vehicles certifying to the standards would be essentially the same whether using conventional or alternate fuels. In practice, reduced differences between conventional and alternate fuel vehicle emission rates may have begun prior to the current set of standards. As such, the emission benefits estimated based on the emission reduction percentages used herein may represent the upper end of emission reductions that might be expected due to the use of alternate fuels.

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CHAPTER III. ALTERNATIVE FUEL STATIONS AND SALES VOLUMES

This chapter provides information about the amount of alternative fuel being used in the three ozone nonattainment areas of Texas and the types of vehicles that use it. The initial work order outlined that Pechan should contact all fueling stations in the ozone nonattainment areas to survey them for data on alternative fuel sales, and the types of vehicles making those purchases. However, Pechan found through initial interviews with alternative fuel stations that the stations were unable to provide sales or customer information. Therefore, the primary method for collecting data about alternative fuel usage in the study areas was to report fuel sales data from corporate headquarters (like Clean Energy) and state and local agencies with experience in monitoring alternative fuel use.

Table III-1 summarizes the primary data sources that were used to estimate alternative fuel sales in BPA, DFW, and HGB by fuel type.

Table III-1. Summary of Data Sources Used to Estimate Alternative Fuel Consumption

Fuel Type	Primary Data Sources
LPG	• Vehicle miles traveled (VMT) estimates for most LPG vehicles are based on data from the Texas Comptroller's Office. • VMT estimates for school buses (not captured in the Comptroller's estimate) come from the Railroad Commission of Texas. • These VMT figures are multiplied by average LPG fuel economy (typically from the Annual Energy Outlook) to estimate total LPG consumption.
CNG	• CNG sales estimates come from Clean Energy, the primary retailer of CNG in Texas. • There are three municipalities which do not purchase their CNG from Clean Energy: Fort Worth Transit, Beaumont Municipal Transit and the City of Lake Jackson. In all three cases, CNG consumption estimates were provided by these agencies.
LNG	• LNG sales estimates come from Clean Energy, the primary retailer of LNG in Texas.

A. ANALYSIS

The U.S. Department of Energy's AFDC was a primary information source on the number and locations of alternative fuels fueling stations in the BPA, DFW, and HGB areas. The AFDC website is located at http://www.afdc.energy.gov/afdc (AFDC, 2010). A summary of statewide statistics are provided in Table III-2.

Table III-2. Alternative Fueling Station Counts for Texas by Fuel Type

Fuel	Statewide Number	DFW Area	HGB Area	BPA Area
CNG	20	10	2	1
Methanol or M85	0	0	0	0
Electric	3	0	0	0
Hydrogen	0	0	0	0
LNG	4	3	1	0

SOURCE: AFDC, 2010.

The AFDC figure for LPG is not listed because it includes all propane retailers, rather than exclusively those who sell propane for vehicle use. This is not an issue for the CNG and LNG estimates, because these fuels are used almost exclusively in vehicles. To provide a more accurate estimate of motor vehicle propane retailers, the Railroad Commission of Texas (RRC of Texas) Propane Directory was used (located at http://www.texaspropane.org). As can be seen in Table III-3, for counties in the three study ozone nonattainment areas, propane retailers are far more prevalent than those of other alternative fuel sources. See Appendix C for the location of all alternative fueling stations in Texas ozone nonattainment counties.

Table III-3. Texas Railroad Commission Estimate of Propane Retailers with Motor Fuel Service (August 2009)

Ozone Nonattainment Area	DFW	HGB	BPA
Propane Retailers in Ozone Nonattainment Counties	74	84	11

SOURCE: RRC, 2010a.

To collect information on liquid fuel consumption, one of the most important information sources used in this analysis was the Texas Comptroller’s Office. The Comptroller monitors all Texas vehicles that purchase liquefied gas in order to assess a fuel tax. Liquefied gas means all combustible gases that exist in the gaseous state at 60 degrees Fahrenheit and at a pressure of 14.7 lbs per square inch (psi) absolute. The tax includes LPG, CNG, LNG, or a mixture of these gases, and excludes gasoline and diesel fuel. A 15 cent per gallon tax is imposed on the use of liquefied gas by motor vehicles in Texas.

Motor vehicle users of liquefied gas, including bi-fuel vehicles, pay in advance annually on each motor vehicle owned, operated, and licensed in Texas. The tax is based on the registered gross weight and miles driven the previous year.

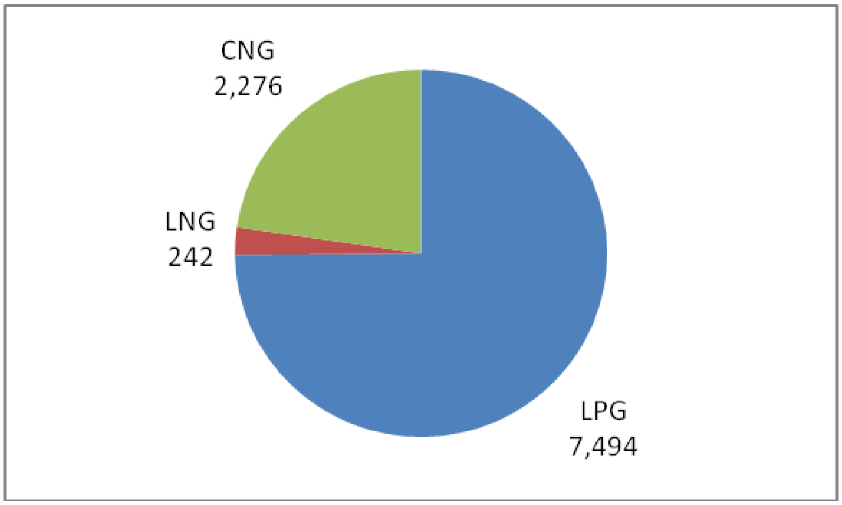
Except for liquefied gas use in highway vehicles, all other sales or uses of liquefied gas are exempt. The following entities are not required to pay the tax or purchase decals:

- Texas public school districts;
- Texas counties;
- Federal Government; and
- Texas non-profit electric and telephone cooperatives.

The tax does not apply to a commercial transportation company that uses the fuel exclusively to provide transportation services to Texas public school districts, and has been issued a vehicle-specific exception letter by the Comptroller.

The Comptroller's Office provided an estimate of alternative fuel vehicles subject to the fuel tax in Texas. As can be seen in Figure III-1, LPG fueled vehicles are by far the most common, whereas LNG is only used in localized areas where refueling is possible.

Figure III-1. Texas Vehicles Subject to Alternative Fuel Tax



Other data sources include the Clean Cities groups in DFW and HGB, various metropolitan transportation authority's (DART, Fort Worth Transit, Beaumont Municipal Transit and Houston Metropolitan Transit Authority), alternative fuel providers (Clean Energy), alternative fuels groups (Propane Council of Texas) and Texas state agencies - RRC of Texas and Texas General Land Office (GLO). By contacting these sources, Pechan was able to put together a general picture of the types of vehicles using alternative fuels and the amount of these fuels being consumed.

1. LPG/PROPANE

While propane is used as a transportation fuel, it is more often used for heating buildings. Therefore, this analysis had to differentiate between propane sold for various purposes. The Texas Comptroller's Office was the primary data source for this information, because the liquid fuels tax only applies to propane sold for transportation purposes. More information on the Texas Comptroller data is included in Appendix A. As can be seen in Table III-4, DFW has significantly more propane vehicles than HGB or BPA.

Table III-4. Non-Exempt LPG Vehicles by Weight Class in the Three Texas Ozone Nonattainment Areas

Vehicle Weight Class	VMT 2009 Estimate in Ozone Nonattainment Areas	DFW Vehicles	HGB Vehicles	BPA Vehicles	Total Vehicles
> 4,000 lbs	515,000	66	4	0	70
4,001 to 10,000 lbs	4,480,000	503	61	11	575
10,001 to 15,000 lbs	437,500	60	5	0	65
15,001 to 27,500 lbs	1,080,000	81	50	1	132
27,501 to 43,500 lbs	457,500	30	21	0	51
Transit Buses	895,000	48	15	1	64

SOURCE: TCO, 2010.

To account for vehicles which are exempt from the liquefied fuel tax, an estimate of the total number of alternative-fueled school buses was obtained from the TX Railroad Commission (RRC, 2010b). Table III-5 shows that there are 772 LPG buses in DFW, with an additional 122 LPG school buses in HGB. VMT was estimated based on the average school bus VMT in three case studies of Texas alternative fuel school buses: Alvin Independent School District (ISD) (RRC, 2009a), Denton ISD (RRC, 2009b) and Dallas County Schools (RRC, 2008). These case studies provided an average annual VMT for LPG buses of 12,548 miles. The estimated VMT of LPG school buses is also shown in Table III-5. For more information on LPG buses, see Appendix D.

Table III-5. LPG School Buses and VMT in Ozone Nonattainment Areas

Ozone Nonattainment Area	LPG School Buses	Estimated LPG VMT
DFW	769	9,649,912
HGB	122	1,530,935
BPA	3	37,646

While public school districts and county school bus fleets have been captured in the Railroad Commission data, LPG consumption from other exempt vehicles proved very difficult to account for. Federally owned alternate fueled vehicles could easily travel across state lines, and no centralized accounting for alternative fuel use by Federal vehicles in Texas could be found. Pechan contacted Texas Electric Cooperatives, an advocacy group representing all Texas cooperatives to get information on the prevalence of alternative fueled vehicles among electric coops. This group was not aware of alternative fueled vehicles being particularly common among the vehicles used by electric cooperatives, although no specific information on their use among the 74 electric cooperatives in Texas was available (TEC, 2010). Likewise, when we contacted Texas Statewide Telephone Cooperative (TSTC), they were not aware of alternative fueled vehicles being common in Texas telephone cooperatives, although again no specific information on their use was available (TSTC, 2010). Therefore, it was assumed that Federally-owned vehicles and Texas non-profit electric and telephone cooperatives do not have significant propane use in the study areas during 2009.

a. DFW

According to the Comptroller data, DFW has more than four times as many LPG vehicles as HGB and BPA combined. The majority of these vehicles are light and medium-duty trucks in the 4,000-10,000 lbs range, which also accounts for more than half of the mileage from alternative fueled vehicles in DFW. For more information, see Table III-6.

Table III-6. LPG Vehicles by Weight Class in the DFW

Vehicle Weight Class	Mileage in Ozone Nonattainment Areas	DFW Vehicles
> 4,000 lbs	485,000	66
4,001 to 10,000 lbs	4,012,500	503
10,001 to 15,000 lbs	390,000	60
15,001 to 27,500 lbs	567,500	81
27,501 to 43,500 lbs	270,000	30
Transit Buses	715,000	48

SOURCE: TCO, 2010.

According to the RRC of Texas, there are 74 propane retailers in the DFW counties which provide motor fuel service. As shown in Table III-7, Tarrant and Dallas counties have the most, with 19 and 15 stations respectively.

Table III-7. LPG Retailers in DFW

County	Number of Propane Retailers with Motor Fuel Service
Collin	8
Dallas	15
Denton	10
Ellis	5
Johnson	5
Kaufman	4
Parker	6
Rockwall	2
Tarrant	19
Total	**74**

SOURCE: RRC, 2010a.

Nearly half of the 1,615 alternative fueled school buses in Texas are located in DFW. Of these, 772 of them are LPG vehicles. The mileage of these buses was calculated based on the average VMT from the three case studies in Texas, as described earlier in the chapter. The breakdown of vehicles by county is included in Table III-8.

Table III-8. LPG School Buses in DFW

County	Number of Buses	Estimated LPG VMT
Collin	32	401,557
Dallas	581	7,290,766
Denton	129	1,618,776
Ellis	6	75,292
Tarrant	21	263,522

SOURCE: RRC, 2010b.

The fuel efficiency figures used in this analysis are shown in Table III-9 below. Mpg estimates for trucks come from the Annual Energy Outlook (AEO) 2009 to estimate LPG vehicle fuel efficiency, unless otherwise specified (DOE, 2009). The mpg estimate for School/Transit Buses comes from a U.S. Department of Energy analysis of the efficiency of alternative fuel school buses (DOE, 2004).

Table III-9. Fuel Efficiency (mpg of Gasoline Equivalent)

24.23	A: Less than 4,000 lbs
14.90[1]	B: 4,001 to 10,000 lbs
8.13	C: 10,001 to 15,000 lbs
8.13	D: 15,001 to 27,500 lbs
7.32	E: 27,501 to 43,500 lbs
7.32	F: 43,501 lbs and over
5.99	School/Transit Buses

Total fuel consumption was estimated based on dividing the estimated VMT by the estimated fuel efficiency for each vehicle type. The resulting fuel consumption in DFW is shown in Table III-10.

Table III-10. Total LPG Fuel Consumption in DFW (Gasoline Gallons Equivalent)

Vehicle Class	Estimated VMT	GGE Consumption
A: Less than 4,000 lbs	485,000	20,017
B: 4,001 to 10,000 lbs	4,012,500	269,231
C: 10,001 to 15,000 lbs	390,000	47,970
D: 15,001 to 27,500 lbs	567,500	69,803
E: 27,501 to 43,500 lbs	270,000	36,885
Transit Buses	715,000	119,444
School Buses	9,649,912	1,612,068
Total		**2,175,418**

[1]The figure used for Class B vehicles was 10.7 mpg of LPG fuel (NREL, 2000). This was converted to mpg of gasoline equivalent based on the relative energy content of each fuel, from an Alternative Fuels Data Center Publication (located here http://www.afdc.energy.gov/afdc/pdfs/afv_info.pdf).

b. HGB

The majority of alternative fueled vehicles in HGB are trucks in the 4,000-10,000 lbs range (61 vehicles) or 15,000 to 27,500 lbs range (50 vehicles), although the latter has the highest estimated VMT. Table III-11 shows the breakdown of alternative fuel vehicles and estimated VMT in HGB.

Table III-11. LPG Vehicles by Weight Class in the HGB

Vehicle Weight Class	Mileage in Ozone Nonattainment Areas	HGB Vehicles
> 4,000 lbs	30,000	4
4,001 to 10,000 lbs	365,000	61
10,001 to 15,000 lbs	47,500	5
15,001 to 27,500 lbs	500,000	50
27,501 to 43,500 lbs	187,500	21
Transit Buses	177,500	15

SOURCE: TCO, 2010.

According to the Railroad Commission of Texas, there are 84 propane retailers in the HGB counties which provide motor fuel service. As shown in Table III-12, Harris County has by far the most, with 35 stations.

Table III-12. LPG Retailers in HGB

County	Number of Propane Retailers with Motor Fuel Service
Brazoria	10
Chambers	4
Fort Bend	7
Galveston	8
Harris	35
Liberty	7
Montgomery	9
Waller	4
Total	**84**

SOURCE: RRC, 2010a.

Of the 122 LPG school buses in HGB, all but ten of them are located in Brazoria County. The mileage of these buses was calculated based on the average VMT from the three case studies in Texas, as described earlier in the chapter. The breakdown of vehicles by county is included in Table III-13.

Table III-13. LPG School Buses in HGB

County	# of Buses	Estimated LPG VMT
Brazoria	112	1,405,449
Harris	10	125,487
SOURCE: RRC, 2010b.		

Fuel consumption estimates have been made for LPG vehicles based on the estimated fuel efficiency multiplied by estimated VMT. LPG mpg efficiency estimates for LPG were presented in Table III-9 earlier. As can be seen in Table III-14, school buses account for the majority of LPG consumption in HGB.

Table III-14. Fuel Consumption in LPG vehicles in HGB

Vehicle Class	Estimated VMT	GGE Consumed
> 4,000 lbs	30,000	1,238
4,001 to 10,000 lbs	365,000	24,491
10,001 to 15,000 lbs	47,500	5,843
15,001 to 27,500 lbs	500,000	61,501
27,501 to 43,500 lbs	187,500	25,615
Transit Buses	177,500	29,652
School Buses	1,530,935	255,751
Total		**404,090**

c. BPA

The Texas Comptroller data indicated that Jefferson is the only county with alternative fuel use in BPA. See Table III-15 for more information on LPG use in BPA.

Table III-15. LPG Vehicles by Weight Class in the BPA

Vehicle Weight Class	Mileage in Ozone Nonattainment Areas	BPA Vehicles
4,001 to 10,000 lbs	102,500	11
15,001 to 27,500 lbs	12,500	1
Transit Buses	2,500	1
SOURCE: TCO, 2010.		

There are 11 propane retailers in BPA according to the Railroad Commission of Texas, far fewer than those found in DFW (74) or HGB (84) counties. As shown in Table III-16, Jefferson County has the most propane retailers, with 5.

Table III-16. LPG Retailers in BPA

County	Number of Propane Retailers with Motor Fuel Service
Hardin	3
Orange	3
Jefferson	5
Total	**11**

SOURCE: RRC, 2010a.

Jefferson County is estimated to have 37,000 annual miles of VMT on its three LPG buses (RRC, 2010b).

Fuel consumption estimates have been made for LPG vehicles based on the estimated fuel efficiency multiplied by estimated VMT. LPG mpg efficiency estimates for LPG were presented in Table III-9 earlier. See Table III-17 for fuel consumption estimates.

Table III-17. Fuel Consumption in LPG vehicles in BPA

	VMT Estimated	GGE Consumed
4,001 to 10,000 lbs	102,500	6,878
15,001 to 27,500 lbs	12,500	1,538
Transit Buses	2,500	418
School Buses	37,646	37,646
Total		**46,479**

2. CNG

CNG is made by compressing natural gas to less than 1 percent its volume at atmospheric pressure. It is used almost exclusively as a transportation fuel, and has several advantages over gasoline, including reduced odor and CAP emissions, as well as safer fuel transport (natural gas evaporates into the air in the event of a spill). The primary data source used for CNG information was Clean Energy, the largest natural gas retailer in Texas. Additional data sources include individual municipal agencies (Fort Worth Transportation Authority, Beaumont Municipal Transit System, and City of Lake Jackson) and the North Central Texas Council of Governments (NCTCOG). The Texas comptroller also provided valuable information on non-exempt CNG vehicles, shown in Table III-18. As with propane vehicles, trucks in the 4,001-10,000 lbs weight category were the most common and accounted for the largest portion of estimated mileage. More information on the NCTCOG data is located in Appendix B.

Table III-18. CNG Vehicles by Weight Class in the Three Texas Ozone Nonattainment Areas

Vehicle Weight Class	Mileage in Ozone Nonattainment Areas	DFW Vehicles	HGB Vehicles	BPA Vehicles	Total Vehicles
< 4,000 lbs	2,080,000	345	5	2	352
4,001 to 10,000 lbs	10,337,500	1,073	72	0	1,145
10,001 to 15,000 lbs	785,000	58	0	0	58
15,001 to 27,500 lbs	922,500	77	0	0	77
27,501 to 43,500 lbs	835,000	60	0	0	60
> 43,501 lbs	15,000	6	0	0	6
Transit Buses	3,190,000	185	13	1	199
Type Z vehicles	12,500	5	0	0	5

SOURCE: TCO, 2010.

a. DFW

Clean Energy owns and operates 9 of the 10 stations in DFW. Those 9 stations sold 2.56 million gasoline gallons equivalent (GGE) of CNG in 2009 (Clean Energy, 2010). These stations and their associated 2009 CNG sales are listed in Table III-19. Two thirds of this total came from the DFW airport station, which fuels numerous private fleets working around the airport (Super Shuttle, The Parking Spot, etc.). The only non-Clean Energy CNG station in DFW is owned by the Fort Worth Transportation Authority (aka “The T”). The T has a fleet of 187 CNG vehicles - 150 CNG buses and 37 CNG paratransit vehicles. These vehicles used 140,000 GGE of CNG in FY 09 (FWTA, 2010). The 2009 CNG sales data received at the facility-level from Clean Energy and the Fort Worth Transportation Authority indicates that DFW area CMG sales to motor vehicles during 2009 was 2.7 million gasoline gallon equivalents.

The North NCTCOG had information on the model years and VMT by all publicly owned CNG and LNG vehicles, as well as some of the privately owned vehicles in DFW (NCTCOG, 2010). The NCTCOG data includes all CNG/LNG vehicles from the following areas:

- Arlington;
- Dallas;
- Irving;
- Flower Mound;
- Richardson;
- Watauga;
- Dallas County;
- Duncanville ISD;
- Mansfield ISD;
- DART;

Table III-19. Texas Clean Energy CNG Sales in 2009

ID	Station Name	Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
6200	DISD Dallas	DFW	11,063	10,396	11,110	10,965	9,851	16,578	10,813	9,829	7,825	10,344	8,924	9,578	127,276
6300	Irving	DFW	1,586	1,733	1,265	1,635	1,688	1,148	1,178	1,615	1,399	1,112	869	874	16,102
6310	Downtown Dallas	DFW	6,826	8,012	8,769	9,115	7,755	13,111	13,333	11,117	11,235	10,793	8,351	10,766	119,183
6360	Garland	DFW	5,473	5,595	5,939	7,036	6,643	3,543	5,573	6,152	4,669	3,611	4,798	5,530	64,562
6400	Cockrell Hill Dallas	DFW	6,800	5,652	6,056	6,496	5,436	4,380	5,733	6,080	4,707	4,566	3,867	4,144	63,917
6560	Fort Worth	DFW	-	62	706	1,577	2,823	2,325	2,027	2,735	2,061	2,463	2,260	2,295	21,334
6650	DFW Airport	DFW	136,695	126,578	142,853	137,226	145,476	151,577	157,778	153,980	144,857	142,081	133,652	137,953	1,710,706
6660	Service Center Dallas	DFW	23,098	22,559	26,736	27,294	26,112	19,190	23,980	24,149	22,206	23,475	20,753	23,154	282,706
6741	City of San Antonio (Take/Pay 10.8K DGE)	Attainment	12,010	12,010	12,010	12,010	12,010	12,010	12,010	18,913	27,634	12,010	23,614	20,320	186,561
6810	Love Field Airport	DFW	10,942	9,514	10,021	9,944	10,560	15,027	13,926	13,283	13,471	15,649	13,994	14,592	150,923
6830	TX DOT Houston	HGB	505	559	669	503	490	454	436	635	950	1,914	1,960	2,053	11,128
6840	O Rourke Houston	HGB	421	535	699	195	163	203	179	222	380	853	341	357	4,548
6890	Parking Spot Austin	Attainment									2,442	4,222	965	1,777	9,406
Total Texas			**215,419**	**203,205**	**226,833**	**223,996**	**229,007**	**239,546**	**246,966**	**248,710**	**243,836**	**233,093**	**224,348**	**233,393**	**2,768,352**
		DFW Total	**202,483**	**190,101**	**213,455**	**211,288**	**216,344**	**226,879**	**234,341**	**228,940**	**212,430**	**214,094**	**197,468**	**208,886**	**2,556,709**
		HGB Total	**926**	**1,094**	**1,368**	**698**	**653**	**657**	**615**	**857**	**1,330**	**2,767**	**2,301**	**2,410**	**15,676**

NOTE: Units are gasoline gallons equivalent.

- FWTA (The T); and
- Privately-owned vehicles operating at DFW International Airport.

This information will be used primarily in the modeling, although it also was valuable as a further check on the numbers of CNG vehicles in the DFW area. See Table III-20, which summarizes the NCTCOG Data. As can be seen in Table III-20, the most common CNG vehicles in DFW public fleets are light duty vehicles and transit buses. The transit buses are driven significantly more than the lighter vehicles, accounting for more than 50 percent of total reported VMT. The VMT figures have been aggregated and adjusted to remove erroneous entries (vehicles with negative VMT or more than 100k VMT annually).

Table III-20. Estimated CNG Public Sector Vehicles and VMT in DFW in 2008

Fuel Type	Vehicle Weight	Estimated 2008 VMT	Estimated # of Vehicles
CNG	A (up to 6000 lbs)	6,707,390	914
CNG	B (6001-8500 lbs)	3,878,490	450
CNG	C (8501-10000 lbs)	1,177,854	133
CNG	E (14001-16000 lbs)	202,158	20
CNG	G (19501-26000 lbs)	41,089	3
CNG	School Bus	9,963	29
CNG	Transit Bus	12,212,581	341

SOURCE: NCTCOG, 2010.

b. HGB

There is significantly less CNG used in HGB than in DFW. There are two Clean Energy stations which sell CNG in HGB, and both are located in downtown Houston. The two Clean Energy stations sold almost 16,000 GGE of CNG in 2009. There are no CNG school buses in HGB, and none of the county governments/municipal fleets include CNG. There is only one major CNG purchaser outside of the Clean Energy stations, and that is the city of Lake Jackson. Lake Jackson has a fleet of 20 light-duty dedicated CNG vehicles (4 Honda Civics and 16 F-150s), as well as 15 heavy CNG vehicles used in their refuse collection fleet. These vehicles are projected to account for 90,000 GGE of CNG in FY 2010, which is larger than any other transportation fuel source in Lake Jackson (CLJ, 2010). Therefore, the total motor vehicle CNG use during 2009 in the HGB area was 106 thousand GGE.

c. BPA

The only CNG use found for the BPA area is by the Beaumont Municipal Transit System. There they have a fleet of 16 CNG buses, and 12 of them are in operation Monday through Saturday. These buses have only been in operation since July 2009, and therefore annual consumption figures were not available. Instead, CNG use was estimated based on monthly totals in July, Aug 09 and Dec 09, Jan 10 (BMT, 2010), as shown in Table III-21. Using these figures, CNG consumption is estimated to be slightly higher during summer months, and annual CNG use in

BPA is estimated to be 240,000 GGE. During calendar year 2009, CNG use in the BPA area was estimated to be 120 thousand GGE.

Table III-21. CNG Use at Beaumont Municipal Transit System

Month	GGE
July 2009	21,859
August 2009	20,660
December 2009	19,222
January 2010	18,148
Estimated Annual Total	240,000

3. LNG

LNG is natural gas which is converted into a liquid phase when kept at a very low temperature (-162° C) in order to reduce its volume. LNG is primarily used as a transportation fuel. The primary data source used for our analysis of LNG was from Clean Energy. They indicated that almost 10 million GGEs of LNG were sold in Texas in 2009. The vast majority of these sales, went to either DART (4.7 million GGE) or Sun Metro in El Paso (also 4.7 million GGE). There was a smaller (0.15 million GGE) amount of LNG used in HGB, and there was none reported in BPA. AFDC data indicates that there are three LNG stations in DFW and one in HGB, all of which are owned by Clean Energy. The complete set of 2009 LNG sales data from Clean Energy Stations is provided in Table III-22.

The Texas comptroller also provided information on LNG vehicles paying fuel taxes, shown in Table III-23. In the case of LNG vehicles, transit buses (primarily owned by DART) accounted for by far the largest portion of the vehicles and overall VMT. This is consistent with the fueling station information that indicates that DART is the major LNG transportation fuel user in Texas.

a. DFW

Clean Energy sold 4.67 million GGEs of LNG to DART in 2009 (Clean Energy, 2010). DART was the only purchaser of LNG in the DFW area, and one of the two major LNG users in the state (the other being in El Paso). This LNG is used to fuel their 179 LNG buses (DART, 2010). There are three LNG stations in Dallas-Fort Worth (two in Dallas County and one in Denton), all of which are owned by Clean Energy. The NCTCOG also has records of LNG consumption in DFW, although these are all from DART. This data indicates that there were 138 LNG buses in DART’s fleet from model year 1998, and an additional 45 buses from MY 2002. These buses are estimated to have traveled 9.9 million miles in 2008 (NCTCOG, 2010).

Table III-22. Texas Clean Energy LNG Sales in 2009

Texas		Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
6820	DART	DFW	362,345	355,965	372,982	383,529	401,527	414,166	430,048	403,106	409,692	387,200	364,633	383,871	4,669,064
6720	HEB Grocery	HGB	20,219	9,865	4,039	20,980	9,149	10,006	9,735	4,732	15,099	7,589	-	-	111,413
6850	CDI (Cryogenic, International Methane)	Unknown	5,903	50,437	-	38,396	10,619	41,564	12,132	24,344	6,338	17,336	23,913	10,057	241,039
TX -8390	LNG Off sales	Unknown	322	10,000	23,394	1,003	11,448	-	918	1,938	-	20,749	1,008	9,623	80,403
6790	Sun Metro	El Paso	368,979	334,556	372,308	381,203	416,945	414,829	436,235	432,407	414,285	431,343	383,141	376,988	4,763,219
6740	SWRI	San Antonio	-	-	1,702	-	4,717	-	6,562	5,037	-	-	10,195	1,364	29,577
6710	Sysco Foods (Houston)	HGB	9,066	-	4,728	-	4,097	4,562	5,072	-	5,221	3,450	-	8,447	44,643
8000	Trimac (Pickens)									7,095	(1)	-	3,593	-	10,687
Total Texas			766,834	760,823	779,153	825,111	858,502	885,127	900,702	878,659	850,634	867,667	786,483	790,350	9,950,045
		DFW Total	**29,285**	**9,865**	**8,767**	**20,980**	**13,246**	**14,568**	**14,807**	**4,732**	**20,320**	**11,039**	**-**	**8,447**	**156,056**
		HGB Total	**362,345**	**355,965**	**372,982**	**383,529**	**401,527**	**414,166**	**430,048**	**403,106**	**409,692**	**387,200**	**364,633**	**383,871**	**4,669,064**

NOTE: Units are gasoline gallons equivalent.

Table III-23. LNG Vehicles by Weight Class in the Three Texas Ozone Nonattainment Areas

Vehicle Weight Class	Mileage in Ozone Nonattainment Areas	DFW Vehicles	HGB Vehicles	BPA Vehicles	Total Vehicles
4,001 to 10,000 lbs	5,000	2	0	0	2
10,001 to 15,000 lbs	7,500	2	1	0	3
15,001 to 27,500 lbs	52,500	3	0	0	3
> 43,501 lbs	122,500	7	0	0	7
Transit Buses	2,712,500	155	0	0	155

SOURCE: TCO, 2010.

b. HGB

Clean Energy also has an LNG station in Houston, which sold primarily to Sysco Foods and HEB Groceries (44,000 and 111,000 GGE, respectively, in 2009). The HEB grocery has a fleet of 42 Class 8 LNG trucks, which average 140,000 miles annually (HEB, 2010). This high mileage toll has actually made LNG trucks less attractive to HEB groceries, because state incentives towards this technology are primarily based on school bus engines which can be maintained for much longer periods. For this reason, HEB Grocery has decided to phase out its LNG fleet.

c. BPA

There is no LNG use in Beaumont-Port Arthur.

4. Electric, Methanol, Hydrogen

AFDC does not include methanol in their survey, and there is no evidence of any methanol stations or methanol fueled highway vehicles in Texas. Methanol is typically produced from natural gas or coal, and can be used to create hydrogen. The fuel is primarily used in racing, because it is less explosive than gasoline, and therefore safer. While there are businesses in Texas that sell methanol fuel, these are not typically traditional fueling stations, and methanol is sold exclusively for specialized, racing purposes. The use of methanol has dramatically declined since the early 1990s, and automakers are no longer manufacturing vehicles that run on it.

The AFDC accounts for three electric vehicle charging stations in Texas, but they are not located in any of the three ozone nonattainment areas. AFDC also does not have record of any hydrogen fueling stations in the state. Both of these technologies require a significant number of vehicles to make the necessary investment worthwhile. At the moment, electric vehicles are rare in this country and typically focus on charging at home. Hydrogen vehicles are not available for commercial use, and it is even less likely that a hydrogen fueling station would be able to sustain itself commercially. Based on this data, Pechan has concluded that there are no significant numbers of electric, hydrogen or methanol vehicles in any of the Texas ozone nonattainment areas.

B. CONCLUSIONS

This section summarizes the study findings about 2009 alternative fuel usage in the three study areas, the vehicle types that are using those fuels, and provides information to inform decisions about how 2018 alternative fuel use in these areas might differ from 2009 estimates.

1. Fuels

Total alternative fuel consumption for the three study areas by fuel type is shown in Table III-24. DFW has the highest level of alternative fuel consumption for all three major fuels. About 90 percent of the alternative fuel use is in the DFW area. LNG is the most prevalent fuel used, and almost all of that consumption is by DART transit buses. CNG consumption was the next largest portion of total alternative fuel consumption, and this is more diffuse across the three nonattainment areas, and across different consumers. LPG fuel consumption is primarily by school buses, although there is LPG use by light-duty vehicles

Table III-24. Total 2009 Alternative Fuel Consumption in Texas Ozone Nonattainment Areas (Gasoline Gallon Equivalent)

	DFW	HGB	BPA	All Ozone Nonattainment Areas
LPG	2,175,418	404,090	46,479	2,625,987
CNG	2,696,709	105,676	240,000*	3,042,385
LNG	4,669,064	156,056	0	4,825,120
Total	**9,541,191**	**665,822**	**286,479**	**10,493,492**

*This is based on an estimate for FY 2010. BPA acquired their CNG fleet in summer 2009, and therefore 2009 CNG consumption would be much lower.

2. Vehicles

One of the key inputs to the Task 4 emission estimates is information about the vehicle characteristics of the alternative fueled vehicles in the DFW, HGB, and BPA areas. The information about the numbers of vehicles in different vehicles classes by fuel types is provided in more detail in the Appendices. This chapter section provides an example of how the information for CNG vehicle travel in the DFW area will be analyzed for use in providing vehicles miles traveled distribution by model year for the alternative fuel fleets emission modeling. This information is shown in Table III-25.

Table III-25. VMT Breakdown by Weight Class for CNG Vehicles in the DFW Area

	Mileage Distribution Percentage					
Model Year	Class A (<6,000 lbs)	Class B (6001-8500 lbs)	Class C (8,501-10,000 lbs)	Class E (14,001-16,000 lbs)	Class G (19,501-26,000 lbs)	Transit Bus
2009	0.0	0.0	0.0	0.0	0.0	0.6
2008	0.1	0.1	0.0	0.0	0.0	8.2
2007	4.4	0.0	0.0	0.0	0.0	5.7
2006	5.6	0.0	0.0	0.0	0.0	17.0
2005	4.6	0.0	0.0	0.0	0.0	19.7
2004	12.0	1.4	25.5	100.0	0.0	13.5
2003	25.8	7.6	4.3	0.0	100.0	3.7
2002	13.7	24.0	43.0	0.0	0.0	21.3
2001	11.6	16.2	4.2	0.0	0.0	0.5
2000	18.4	23.2	19.3	0.0	0.0	9.9
1999	3.7	14.0	3.3	0.0	0.0	0.0
1998	0.0	3.1	0.0	0.0	0.0	0.0
1997	0.0	10.3	0.2	0.0	0.0	0.0
1996 and earlier	0.0	0.0	0.0	0.0	0.0	2.8

SOURCE: NCTCOG, 2010.

3. Forecasts

Several recent actions indicate the direction that Texas is moving with respect to alternative fuel use. In October, 2009 DART made the decision to purchase nearly 600 CNG buses (DMN, 2009). This would essentially replace the existing bus fleet, as DART has 740 total buses according to their website. It remains to be seen how the recent budget crunch will impact the adoption of alternative fueled vehicles. It is possible that DART will attempt to maintain their existing fleet for the time being as a cost-saving measure (DART, 2010). Given that DART is by far the largest consumer of LNG in any of the ozone nonattainment areas, it is likely that this conversion to CNG will further reduce the LNG consumption in the state. On the other hand, this purchase of 600 CNG buses, along with the conversion to CNG buses by Beaumont Municipal Transit indicates that CNG buses will remain popular among transit providers in the state.

LPG has been touted as a local fuel source, with comparatively stable prices. This, in addition to the numerous incentives to convert Texas school buses to LPG, has made these buses increasingly popular among Texas school districts. Programs to encourage LPG school buses in Texas include the Railroad Commission of Texas's Low Emissions Propane Equipment Initiative Program and NCTCOG's Clean School Bus Program. Both of these programs provide funding for LPG conversions to reduce school bus emissions. Given this information, it is highly likely that LPG buses, which already make up a significant portion of school buses in areas like Dallas and Denton counties, will only grow more prevalent in Texas.

There is a potential for increased LNG use by heavy-duty trucks that traditionally use diesel fuel. Some short-haul and regional trucking companies are already successfully using LNG to move their freight. Trucks which do drayage in and out of ports daily are seeing the most benefit from using LNG fuel. These trucks can return to their yards every night for fueling, which makes it cost effective to have a fueling station on-site or nearby. Currently, though, there is only one LNG fueling station in the Texas Gulf Coast study areas. (This station is in Houston.) Additional infrastructure in the BPA and HGB port areas would make LNG trucks more viable for short and medium range duty.

There is also potential growth in the near future for long-haul LNG trucks. For the moment, natural gas powered trucks remain tethered to a fuel supply, and limited in range by fuel tank capacity. LNG is stored at very cold temperatures and under pressure, so it requires a specialized distribution network and fueling facilities. This limits the types of applications that LNG-powered trucks can serve. The potential long haul truck near future for LNG may be via a hub-and-spoke model. In this model, the fleets would put fueling stations at some of their terminals and LNG tractors would run between terminals where fuel is available.

LNG trucks have higher initial cost than diesel trucks, but lower fuel costs. LNG trucks have more limited range on a tank of fuel, and the weight of the fuel tank is heavier than for a diesel truck.

Pechan also reviewed national and regional alternative fueled vehicle energy consumption and sales forecasts from the Annual Energy Outlook 2010 (AEO 2010). AEO 2010 national transportation sector energy use by type forecasts for 2018 relative to 2009 show that diesel use is expected to increase by 19 percent, LPG usage expected to decline by 17 percent, electricity usage increasing from 1.8 to 150.9 trillion Btus, and CNG use increasing by 59 percent. AEO 2010 also includes vehicle sales forecasts for the East South Central region, which includes Texas. Their light-duty vehicle sales forecast shows alternatives to gasoline continuing to be ethanol-flexible fueled vehicles and electric-gasoline hybrids.

C. UNCERTAINTIES

This section describes some of the potential uncertainties with the alternative fuel use and vehicle type information presented in this report.

Clean Energy data was used as the primary data source for CNG and LNG sold in the nonattainment areas. Pechan also contacted The Texas GLO, which indicated that there were three municipalities which purchased their natural gas from the GLO directly. These three (Beaumont Municipal Transit, Fort Worth Transit and the City of Lake Jackson) have all been contacted directly and incorporated into overall totals.

LNG consumption in DFW is entirely by DART’s fleet of 183 LNG transit buses. Uncertainty arises when LNG consumption is compared with the CNG figure for DFW, in light of the information from the NCTCOG and Comptroller data. Both of these data sources indicate that there are more CNG transit buses than LNG transit buses in DFW. In addition, they also predict that the VMT from CNG transit buses is higher than that for LNG buses. In spite of this, LNG in DFW accounts for 4.7 million GGE, whereas CNG in DFW (transit buses as well as all other vehicle types) accounts for only an estimate 2.7 million GGE. In Pechan’s communication with NCTCOG, they indicated that their information on VMT and fuel consumption was likely to be less accurate than that of Clean Energy. However, the NCTCOG estimate for CNG consumption in DFW was 5.6 million GGE, which implies that the current estimate may be low. It remains possible that there is CNG consumption other than that at Clean Energy and The T, although Pechan found no evidence of where this additional CNG use may be taking place.

The NCTCOG estimate for fuel consumption comes from an annual survey that is sent to all Clean Cities Technical Coalition Stakeholders. These include all public and most private fleets. This is a survey that all Clean Cities coalitions across the country complete for an annual report to the DOE.

If the Comptroller data is used as a reference, total CNG consumption in HGB is within the range of expected values. Comptroller data indicates there should be very little CNG consumption in BPA, but given that the Beaumont Municipal Transit fleet only acquired CNG vehicles in summer of 2009, the discrepancy is understandable. The Comptroller data indicates very few non-exempt LNG vehicles in either HGB or BPA, although LNG consumption in these areas is also low.

Propane usage during 2009 has been estimated based primarily on vehicle counts by types and weight class and published data on average annual mileage and fuel economy. These fuel use estimates are more uncertain than if direct motor vehicle propane sales data had been available.

The non-exempt vehicle information provided by the Texas Comptroller of Public Accounts identified vehicle location according to the mailing address file in their database. These addresses may not always correspond to actual vehicle locations. In addition, vehicles may operate outside the counties and metropolitan areas where they are garaged.

The U.S. Department of Energy's Energy Information Administration State Energy Data System (SEDS) provides Transportation Sector Energy Consumption Estimates for 2007 that can be used to check/verify the motor vehicle alternative fuel use estimates that are provided in the previous sections. The 2007 summaries are the most recent reporting by EIA of state energy data. SEDS reports the following transportation sector energy consumption in Texas during 2007:

Transportation Fuel	Energy Consumption	GGEs
Natural gas	94.5 trillion Btu	294 million
LPG	1.3 trillion Btu	11.4 million

Note that transportation use of natural gas reported in SEDS is gas consumed in the operation of pipelines, primarily in compressors, and gas consumed as vehicle fuel. Therefore, the estimate above will contain more than just motor vehicle usage. The gasoline gallons equivalents are computed values based on standard conversion factors. Because the above-listed transportation sector energy consumption estimates are statewide values, and can include more than motor vehicle usage, they would be expected to be upper limit values when compared with BPA, DFW plus HBG area totals. In the context of an uncertainty analysis, they tell us that this study has probably not overestimated motor vehicle alternative fuel use in the study areas.

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CHAPTER IV. ALTERNATIVE FUEL EMISSION REDUCTION ANALYSIS

A. BACKGROUND AND INTRODUCTION

This chapter provides the findings of Task 4 of the subject study, which is an alternative fuel emissions reduction analysis. This chapter provides an estimate of the changes in criteria pollutant emissions resulting from the use of alternative fuel vehicles refueling at public and privately-owned alternative fuel stations located in counties within the BPA, DFW, and HGB ozone nonattainment areas, as compared to criteria pollutant emissions that would have been emitted by a comparable diesel-fueled vehicle. This report builds upon the information gathered in Tasks 2 and 3 of this project, which were reported in Chapters II and III of this report.

B. ALLOCATION OF FUEL VOLUMES

The alternative fuel consumption totals were estimated in Chapter III, and are summarized here in Table IV-1. This chapter describes how these fuel consumption totals were allocated across vehicle type and age in order to make an estimate of the change in emissions. Vehicle type and weight are significant characteristics, because they impact the type of engine that will be used, and engines used for different weight categories often have significantly different emissions profiles. Vehicle age is likewise significant because older vehicles are less likely to use an advanced technology engine. In addition, newer models are subject to much stricter emissions control standards, and therefore typically have much lower emissions. Once an estimate is made of the total fuel consumption across all different vehicle types/weights and the different vehicle ages, then a complete picture of emissions changes can be formulated.

Table IV-1. Total 2009 Alternative Fuel Consumption in Texas Ozone Nonattainment Areas (Gasoline Gallon Equivalent)

	DFW		HGB		BPA	
	Number of Facilities	**Fuel Quantities**	**Number of Facilities**	**Fuel Quantities**	**Number of Facilities**	**Fuel Quantities**
LPG	74	2,175,418	84	404,090	11	46,479
CNG	10	2,696,709	2	105,676	1	240,000*
LNG	3	4,669,064	1	156,056	0	0
Total	**87**	**9,541,191**	**87**	**665,822**	**12**	**286,479**

*This is based on an estimate for FY 2010. BPA acquired their CNG fleet in summer 2009, so 2009 CNG consumption is much lower than the 2010 estimate.

1. 2010

a. LPG

Information on LPG consumption came from the Texas Office of the Comptroller. The Comptroller's office had information on LPG consumption by vehicle type and weight, although this source classified vehicles by different weight categories than the weight categories that were requested to be used in this project (i.e., the 13 diesel vehicle classes included in EPA's MOBILE6 emission factor model). In order to calculate emissions changes, the LPG consumption data needed to be distributed to the appropriate MOBILE6 categories. Table IV-2 outlines how the fuel volumes from the Comptroller's office were allocated into MOBILE6 categories. In cases where the Comptroller vehicle weight class included multiple MOBILE6 vehicle weight classes, fuel was allocated based on the VMT distribution from the Dallas area. For example, the Comptroller category D (15,001 to 27,500 lbs) fuel consumption needed to be allocated to heavy-duty vehicles in class 5 (16,000-19,500 lbs) and 6 (19,500-26,000 lbs). The Dallas VMT data indicated that class 5 vehicles made up a much smaller portion of total Dallas VMT than class 6 vehicles, and therefore the fuel consumption is distributed accordingly. The Dallas VMT allocation was used for all three areas, because it was assumed that there is no significant difference between the weights of vehicles driven in the three nonattainment areas. Fuel consumption was allocated by vehicle age according to EPA's national registration distribution data for those vehicle types.

Table IV-2. Comptroller and MOBILE 6 Vehicle Classifications

Comptroller Vehicle Class	Percent Allocated	MOBILE6 Vehicle Class
A: Less than 4,000 lbs	100%	Light Duty Vehicles
B: 4,001 to 10,000 lbs	0.3%	Light Duty Diesel Trucks 1,2 (0-6,000 lbs)
	6.8%	Light Duty Diesel Trucks 3,4 (6,000-8,500 lbs)
	92.9%	Heavy Duty Diesel Vehicles 2b (8,500-10,000 lbs)
C: 10,001 to 15,000 lbs	100%	Heavy Duty Diesel Vehicles 3 (10,000-14,000 lbs)
D: 15,001 to 27,500 lbs	17.1%	Heavy Duty Diesel Vehicles 5 (16,000-19,500 lbs)
	82.9%	Heavy Duty Diesel Vehicles 6 (19,500-26,000 lbs)
E: 27,501 to 43,500 lbs	53.6%	Heavy Duty Diesel Vehicles 7 (26,000-33,000 lbs)
	46.4%	Heavy Duty Diesel Vehicles 8a (33,000-60,000 lbs)
Transit Buses	100%	Transit Buses
School Buses	100%	School Buses

b. CNG

The distribution of CNG fuel consumption in DFW was estimated based on information from the NCTCOG. The NCTCOG provided information on vehicle mileage of CNG vehicles by vehicle model year and by vehicle weight category. The NCTCOG vehicle weight categories were the same as the MOBILE6 vehicle weight categories. The mileage estimates were divided by a MOBILE6 estimate of the fuel economy (in mpg) for the different vehicle classes to estimate the corresponding fuel consumption by vehicle class and age. Total CNG consumption in DFW, as shown in Table IV-1, was then allocated using this estimated distribution.

CNG consumption in HGB comes from two sources: the City of Lake Jackson (90,000 GGE) and Clean Energy sales (15,000 GGE). Because no information was available about the types of vehicles purchasing CNG at Clean Energy stations, the City of Lake Jackson's fleet was used as a surrogate for the entire HGB area. Lake Jackson has a fleet of 4 Honda Civics (light-duty vehicles), 16 F-150s (light-duty diesel trucks 1,2) and 15 refuse collection vehicles. While it is not known the exact size of these vehicles, for the purposes of this analysis, it was assumed that these refuse trucks were heavy-duty diesel vehicle class 6 (19,500-26,000 lbs). No information was available about the breakdown of fuel consumption between these vehicles, so it was assumed that all vehicles were driven a similar annual distance, and consumption was adjusted according to the number of each of these vehicles and their respective mpg. While no specific vehicle age information was found, communication with the Lake Jackson fleet indicated that all of the vehicles were between MY2009 and MY2001. Therefore, an even distribution of vehicles across these model years was assumed.

The only consumer of CNG in BPA is Beaumont Municipal Transit, which has a fleet of 16 CNG buses, all of which are model year 2009. Therefore, all CNG consumption in BPA is allocated to transit buses of the 2009 model year.

c. LNG

Allocating the LNG fuel consumption was relatively simple in DFW, because the only LNG vehicles in the area are transit buses. Information from the NCTCOG indicated that the fleet is composed of vehicles from 1998 and 2002. Fuel consumption was allocated according to the number of vehicles in each model year.

Based on information from Clean Energy, LNG in Houston is primarily distributed through two retailers: HEB Groceries (with 110,000 GGE of LNG used in 2009) and Sysco Foods (40,000 GGE of LNG used in 2009). HEB groceries indicated that their fleet was comprised of 42 heavy trucks used for hauling, with no further information provided on this fleet. Therefore, LNG trucks in HGB were assumed to range in size between class 3 (10,000-14,000 lbs) and class 8a (33,000-60,000 lbs), and fuel consumption was distributed evenly across these categories. Vehicle age was also not known for this category, so they were distributed according to EPA's national registration distribution data for those vehicle types.

There was no LNG fuel consumption in BPA.

2. 2018 Forecast

There were several key elements needed in order to forecast fuel consumption for the year 2018. First, population growth was used as a surrogate for growth in fuel consumption in cases where more specific information on fuel consumption changes was not available. This information came from the Texas State Data Center and Office of the State Demographer, which provided a population growth estimate for each of the three metropolitan areas for 2010-2020[2]. These were then adjusted downward to account for the difference in timeframe in order to express expected population growth between 2010 and 2018. The population growth rates for each area are shown in Table IV-3. DFW and HGB both showed significant growth in the forecast period, whereas BPA indicated a small population decline.

[2]Based on population growth rate between 2010-2020 for the three metropolitan areas according to Texas State Data Center and Office of the State Demographer. http://txsdc.utsa.edu/cgi-bin/prj2008totnum.cgi accessed on 5/27/10.

Table IV-3. Growth Rates used for Nonattainment Areas

	DFW	HGB	BPA
Total Growth Rate (2010-2018)	27.0%	24.4%	-1.0%

a. LPG

In recent years, DFW has made a significant push towards LPG school buses. The other two nonattainment areas do not have a similar portion of their school bus fleet from LPG vehicles, although the push towards LPG as a fuel source local to Texas is continuing. Based on this effort, it was assumed that HGB will have a significant increase in their LPG school bus fleet by 2018. It is assumed that by 2018, HGB will have fuel consumption from school buses equal to the school bus fuel consumption in DFW in 2009. All other LPG consumption in HGB is held constant at 2009 levels. DFW and BPA are assumed to have their LPG consumption increase at the same rate as population growth. LPG fuel consumption in each of the three areas in 2009 and 2018 is shown in Table IV-4.

Table IV-4. LPG Estimated Fuel Consumption in 2009 and 2018 (GGE)

	DFW	HGB	BPA	All Ozone Nonattainment Areas
2009	2,175,418	404,090	46,479	2,625,987
2018	2,761,848	1,760,407	46,031	4,568,286

b. LNG

Perhaps the most significant change expected in alternative fuel use in the Texas nonattainment areas is the expected decrease in LNG consumption, as shown in Table IV-5. In the 2009 fuel consumption estimate, LNG has the highest consumption of the three fuels included in this analysis. Virtually all (97 percent) of this consumption is occurring as a result of DART's LNG fleet. Discussions with DART and various news clippings indicate that DART is shifting away from an LNG fleet and has purchased CNG buses to replace them. Based on this information, DART's LNG fuel consumption in 2009 is entirely shifted to CNG fuel consumption in 2018. As a result, the CNG consumption in DFW is far higher than it was in 2009, and LNG consumption is forecast to be zero. HEB Groceries also indicated that their LNG fleet was no longer cost effective, and that they were in the process of shifting their fleet towards some other fuel, likely diesel. Based on this, the share of LNG consumption from HEB Groceries has been removed from the 2018 fuel forecast in HGB. BPA was not forecast to have any LNG because there was no LNG in BPA as of 2009.

Table IV-5. LNG Estimated Fuel Consumption in 2009 and 2018 (GGE)

	DFW	HGB	BPA	All Ozone Nonattainment Areas
2009	4,669,064	156,056	0	4,825,120
2018	0	44,643	0	44,643

c. CNG

Table IV-6 shows how CNG usage is estimated to change from 2009 to 2018. CNG fuel consumption is estimated to grow at the same rate as population growth for the HGB and BPA nonattainment areas. The DFW CNG fleet is growing dramatically because of the predicted shift by DART from LNG to CNG buses. This accounts for the large increase predicted in CNG consumption in the DFW area.

Table IV-6. CNG Estimated Fuel Consumption in 2009 and 2018 (GGE)

	DFW	HGB	BPA	All Ozone Nonattainment Areas
2009	2,696,709	105,676	240,000	3,042,385
2018	7,365,773	131,439	237,690	7,734,902

Total projected fuel consumption is displayed in Table IV-7 below.

Table IV-7. 2018 Projected Fuel Consumption Summary

	DFW	HGB	BPA	All Ozone Nonattainment Areas
LPG	2,761,848	1,760,407	46,031	4,568,286
CNG	7,365,773	131,439	237,690	7,734,902
LNG	0	44,643	0	44,643
Total	**10,127,621**	**1,936,489**	**283,721**	**12,347,831**

3. 2018 Forecast Allocation

The 2018 forecast fuel consumption was allocated to vehicle type and model years in a very similar manner as the 2009 fuel consumption estimate. In most cases, there was no information on which to make an estimate of a change in the breakdown of vehicle classes and model years. Therefore, it was assumed that all vehicle weight classes did not change from 2009 to 2018, and that model years would be advanced nine years, in order to have a comparable vehicle age distribution of the fleet for the year 2018. This method was used for many, but not all of the areas/fuels in this analysis, as described below.

a. LPG

LPG in DFW and BPA were distributed in the same manner as in the 2009 estimate. In HGB, the fuel consumption was held constant in all vehicle categories with the exception of school buses, because it was assumed that the increase in HGB LPG consumption is due to an increase in LPG buses. Therefore, in the 2018 estimate, school buses make up a much larger portion of overall LPG consumption than in 2009.

	LDV	LDT1,2 (0-6,000 lbs)	LDT (6,000-8,500 lbs)	HDDV (8,500-10,000 lbs)	HDDV (10000-14000 lbs)	HDDV (16,000-19,500 lbs)	HDDV (19,500-26,000 lbs)	HDDV (26,000-33,000 lbs)	HDV (33,000-60,000 lbs)	School Bus	Transit Bus
DFW 2010	20,017	767	18,409	250,055	47,970	12,465	57,338	19,779	17,106	1,612,068	119,444
DFW 2018	25,412	974	23,371	317,462	60,902	15,825	72,795	25,111	21,718	2,046,634	151,643
HGB 2010	1,238	70	1,675	22,746	5,843	10,982	50,518	13,735	11,879	255,751	29,652
HGB 2018	1,238	70	1,675	22,746	5,843	10,982	50,518	13,735	11,879	1,612,068	29,652

	LDV	LDT1,2 (0-6,000 lbs)	LDT (6,000-8,500 lbs)	HDDV (8,500-10,000 lbs)	HDDV (10000-14000 lbs)	HDDV (16,000-19,500 lbs)	HDDV (19,500-26,000 lbs)	HDDV (26,000-33,000 lbs)	HDV (33,000-60,000 lbs)	School Bus	Transit Bus
BPA 2010	0	20	470	6,388	0	275	1,263	0	0	37,646	418
BPA 2018	0	19	466	6,326	0	272	1,251	0	0	37,284	414

b. CNG

The CNG estimate for HGB uses the same fuel distribution as the 2009 estimate. The estimate for BPA did not use the same distribution, but instead assumes that BPA will still be operating their current fleet. This assumption was made because the current bus fleet was purchased in 2009, and it may still be in operation in 2018. The DFW estimate for CNG uses the same fuel distribution for all categories except that all of the additional growth is assigned to transit buses, because DART is currently undergoing a significant expansion of their CNG fleet. Table IV-8 summarizes the CNG allocation across vehicle type.

Table IV-8. Allocation of CNG Fuel by Vehicle Type (GGE)

	Light Duty Vehicles	Light Duty Trucks (6001-8500 lbs)	HDDV (8,501-10,000 lbs)	HDDV (14,001-16,000 lbs)	HDDV (19,501-26,000 lbs)	Transit Bus	School Bus
DFW 2010	155,238	171,639	68,449	14,965	3,562	2,254,952	27,904
DFW 2018	155,238	171,639	68,449	14,965	3,562	6,924,016	27,904
HGB 2010	5,077	29,774	0	0	70,825	0	0
HGB 2018	6,315	37,033	0	0	88,091	0	0
BPA 2010	0	0	0	0	0	240,000	0
BPA 2018	0	0	0	0	0	237,690	0

c. LNG

There is no LNG consumption forecast in DFW or BPA. The fuel consumption in HGB is allocated in the same manner as the 2009 forecast, although the total has declined significantly due to the scheduled elimination of the HEB Groceries LNG fleet.

	HDDV (10000-4000 lbs)	HDDV (14,000-16,000 lbs)	HDDV (16,000-19,500 lbs)	HDDV (19,500-26,000 lbs)	HDDV (26,000-33,000 lbs)	HDV8a (33,000-60,000 lbs)
HGB 2010	26,009	26,009	26,009	26,009	26,009	26,009
HGB 2018	7,440.5	7,440.5	7,440.5	7,440.5	7,440.5	7,440.5

C. ESTIMATION OF EMISSION REDUCTIONS

1. Introduction

Prior to calculating the emission changes from the use of alternate fuels, all of the fuel volumes were converted from GGE to diesel gallon equivalents (DGE). This was important in order to be consistent with the derivation of the baseline g/mi emission rates and the conversion of the emission rates to g/gal using the diesel fuel economy values, which are based on diesel fuel. The value used for this conversion was 0.88, indicating that the same energy content from one gallon of gasoline can be derived from 0.88 gallons of diesel fuel.

To calculate the changes in emissions resulting from the use of alternate fuels in the Texas nonattainment areas, a spreadsheet was developed starting with the MOBILE6 output post-processed to contain the vehicle type code, mpg fuel economy value, and g/mi emission factor for each vehicle type and model year for VOC, CO, NO_x, PM_{10}, and $PM_{2.5}$ for all diesel vehicles. (The derivation of the baseline MOBILE6 emission rates was discussed in the Task 2 report for this project). The g/mi emission factors were converted to g/gal by multiplying the g/mi emission rate by the corresponding fuel economy value to estimate the baseline g/gal emission rate. The diesel emission rates in g/gal were reduced by the alternate fuel emission reduction percentages reported in Chapter II to obtain g/gal emission rates for the alternate fuels. These g/gal alternate fuel emission rates were then subtracted from the corresponding diesel g/gal emission rates to estimate the change in emissions per gallon of diesel fuel. These values were then multiplied by the diesel gallon equivalents to estimate an annual emission change due to the use of alternate fuels. The annual emissions changes were then summed over all model years by vehicle type.

For the vehicle types that used gasoline as the baseline from which the emission reductions were calculated, the g/gal emission rate of the alternate fuel was calculated from the g/gal gasoline baseline (calculated from MOBILE6 in the same manner as the diesel baseline emission rates). Since the project required that the alternate fuel emissions be compared to a diesel baseline, and because the light-duty g/gal alternate fuel emission rates were derived from a gasoline g/gal basis, these alternate fuel emission rates needed to be converted to an equivalent g/gal diesel fuel emission rate. Thus, the alternate fuel emission rates were first divided by 0.88 to put the emission rates on a consistent basis. The difference in these emission rates was then multiplied by the calculated diesel equivalent gallons, as discussed above for the other vehicle types.

Note that in some cases in the results analysis presented below that emission increases are predicted. This generally occurs because the light-duty CNG and LNG and all LPG emission reductions were based on gasoline vehicles. Thus, the alternate fuel emission rates for these vehicles was estimated by applying a percentage reduction to a baseline gasoline vehicle and then converted to a comparable diesel-based rate, as discussed above. In most cases, VOC and CO emission rates for gasoline vehicles are much higher than they are for diesel vehicles in the same weight category. Therefore, increases in VOC and CO are often seen in the results presented below.

2. Nonattainment Area Results by Fuel Type

a. DFW

Table IV-9 shows the DFW area emissions analysis results for CNG use. The emission results for CNG use in the DFW area are dominated by transit buses – which consume almost 85 percent of the CNG in this area during 2009. The NO_x emission benefit of CNG use in the DFW area is estimated to be 0.2 tpd and the $PM_{2.5}$ emission benefit is 4.7×10^{-3} tpd. There is a modest estimated increase in CO emissions which is estimated for the light-duty fleet.

Table IV-9. Annual Emission Changes in 2010 for DFW Area from the Use of CNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	65,149	0.153	-3.429	0.124	0.168	0.155
LDT12	71,460	0.181	-4.678	-0.414	0.133	0.123
LDT34	151,043	1.509	-11.145	-0.693	0.266	0.245
HDV2B	60,235	0.146	0.572	2.467	0.037	0.035
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	13,169	0.001	0.147	0.239	0.011	0.010
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	3,135	0.000	0.041	0.069	0.004	0.004
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	1,984,358	0.000	0.000	63.106	1.093	1.006
School Bus	24,555	0.000	0.000	1.005	0.020	0.019
Total	**2,373,104**	**1.990**	**-18.492**	**65.902**	**1.733**	**1.596**

Table IV-10 shows that the expected NO_x emission reduction in the DFW area for LNG use is similar to what is estimated for CNG. LNG is solely used in this area in transit buses, so all of the emissions difference is a result of the lower estimated CAP emissions per mile for LNG-fueled versus diesel-fueled buses pre-2007 model year. CO emission reductions in the DFW area associated with LNG usage (0.16) are similar in magnitude to those for NO_x (0.15 tpd).

Table IV-10. Annual Emission Changes in 2010 for DFW Area from the Use of LNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	0	0.000	0.000	0.000	0.000	0.000
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	0	0.000	0.000	0.000	0.000	0.000
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	4,108,776	4.281	58.831	53.966	2.634	2.425
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**4,108,776**	**4.281**	**58.831**	**53.966**	**2.634**	**2.425**

LPG is used in a wide range of vehicle types in the DFW area, but the emissions difference relative to using conventional diesel in these vehicles is modest. The LPG emission benefit ranges from less than 0.2 tpd for NO_x to 0.01 tpd for PM_{10} and $PM_{2.5}$. The DFW LPG emissions results are summarized in Table IV-11. Slight emission increases are expected in VOC and CO emissions.

Table IV-11. Annual Emission Changes in 2010 for DFW Area from the Use of LPG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	17,615	-0.256	-2.003	0.040	0.034	0.031
LDT12	675	-0.004	-0.072	-0.003	0.001	0.001
LDT34	16,200	-0.107	-1.344	-0.012	0.013	0.012
HDV2B	220,048	-0.739	-9.337	3.129	0.111	0.105
HDV3	42,214	-0.204	-1.614	0.657	0.020	0.019
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	10,969	-0.100	-0.390	0.240	0.009	0.009
HDV6	50,458	-0.186	-1.927	1.359	0.059	0.056
HDV7	17,406	-0.062	-0.563	0.567	0.018	0.017
HDV8a	15,053	-0.107	-0.348	0.750	0.029	0.028
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	1,418,620	-8.154	-40.594	48.178	3.279	3.094
School Bus	105,111	-0.192	-2.932	3.494	0.143	0.134
Total	**1,914,368**	**-10.111**	**-61.123**	**58.402**	**3.717**	**3.505**

b. HGB

HGB area alternative fuel volumes are much less than those in the DFW area, so the emission changes with alternative fuel use are much lower as well. CNG use in the HGB area is estimated to be producing about a 1.2 ton per year CO emission increase and a 0.7 ton per year NO_x emission decrease in the base year. VOC and PM emission differences are even smaller as shown in Table IV-12, with decreases expected in PM and a very slight increase expected in VOC.

Table IV-12. Annual Emission Changes in 2010 for HGB Area from the Use of CNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	4,468	-0.001	-0.215	-0.010	0.006	0.006
LDT12	26,201	-0.004	-1.562	-0.075	0.026	0.024
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	62,326	0.000	0.532	0.810	0.056	0.051
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	0	0.000	0.000	0.000	0.000	0.000
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**92,995**	**-0.005**	**-1.245**	**0.725**	**0.087**	**0.080**

LNG is used in the HGB area in some heavy-duty vehicle applications. This alternative fuel usage is estimated to reduce NO_x emissions by about 0.01 tpd – and provide lesser reductions of the other CAPs studied. Table IV-13 summarizes the HGB reduction estimates for LNG.

Table IV-13. Annual Emission Changes in 2010 for HGB Area from the Use of LNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	0	0.000	0.000	0.000	0.000	0.000
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	22,888	0.002	0.141	0.363	0.019	0.017
HDV4	22,888	0.002	0.176	0.409	0.019	0.017
HDV5	22,888	0.003	0.230	0.528	0.027	0.025
HDV6	22,888	0.000	0.221	0.325	0.031	0.029
HDV7	22,888	0.000	0.260	0.423	0.029	0.027
HDV8a	22,888	0.000	0.459	0.647	0.049	0.045
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	0	0.000	0.000	0.000	0.000	0.000
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**137,329**	**0.007**	**1.487**	**2.696**	**0.174**	**0.160**

LPG is used in a wide range of vehicle types in the HGB area, but at the quantities used, just provides modest emission reductions. Table IV-14 shows that the current LPG benefit in HGB area motor vehicles is 0.03 tpd of NO_x and PM benefits about a tenth of the NO_x benefit. Slight increases in CO and VOC are also expected.

Table IV-14. Annual Emission Changes in 2010 for HGB Area from the Use of LPG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	1,090	-0.016	-0.124	0.002	0.002	0.002
LDT12	61	0.000	-0.007	0.000	0.000	0.000
LDT34	1,474	-0.010	-0.122	-0.001	0.001	0.001
HDV2B	20,017	-0.067	-0.849	0.285	0.010	0.010
HDV3	5,141	-0.025	-0.197	0.080	0.002	0.002
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	9,664	-0.088	-0.343	0.212	0.008	0.008
HDV6	44,456	-0.164	-1.698	1.197	0.052	0.049
HDV7	12,087	-0.043	-0.391	0.394	0.013	0.012
HDV8a	10,454	-0.075	-0.242	0.521	0.020	0.019
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	26,094	-0.107	-0.683	0.872	0.019	0.019
School Bus	225,061	-0.941	-7.422	7.418	0.865	0.808
Total	**355,599**	**-1.536**	**-12.078**	**10.981**	**0.994**	**0.930**

c. BPA

CNG is used in BPA area transit buses. However, because these buses were recent purchases and all meet the 2007 plus model year heavy-duty diesel vehicle emission standards, no emission benefit for this CNG usage is estimated. There is some LPG/propane used in school buses and light-duty applications in the BPA area, but the estimated NO_x benefit is 0.003 tpd. Estimated PM emission reductions from LPG use in the BPA area are less than those for NO_x. Minimal increases in VOC and CO emissions are expected in the BPA area from the use of LPG. BPA emission results are shown in Tables IV-15 and IV-16. There is no estimated LNG use in the BPA area during 2010, so there is no emission reduction estimate for this area-fuel type combination.

Table IV-15. Annual Emission Changes in 2010 for BPA Area from the Use of CNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	0	0.000	0.000	0.000	0.000	0.000
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	0	0.000	0.000	0.000	0.000	0.000
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	211,200	0.000	0.000	0.000	0.000	0.000
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**211,200**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Table IV-16. Annual Emission Changes in 2010 for BPA Area from the Use of LPG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	17	0.000	-0.002	0.000	0.000	0.000
LDT34	414	-0.003	-0.034	0.000	0.000	0.000
HDV2B	5,621	-0.019	-0.239	0.080	0.003	0.003
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	242	-0.002	-0.009	0.005	0.000	0.000
HDV6	1,111	-0.004	-0.042	0.030	0.001	0.001
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	368	-0.002	-0.010	0.012	0.000	0.000
School Bus	33,128	-0.139	-1.093	1.092	0.127	0.119
Total	**40,901**	**-0.168**	**-1.428**	**1.219**	**0.132**	**0.124**

d. 2018 Results

Tables IV-17 through IV-23 provide the alternative fuel emission reduction estimates for the 2018 forecast year. Table IV-17 shows that 2018 estimated CNG usage in the DFW area is the same as in 2010, with the exception of transit buses. CNG-fueled bus purchase plans for the DFW area are expected to increase CNG usage by this vehicle type. However, the emission benefit for CNG use in transit buses is expected to be smaller in 2018 than it is in 2000 because modern technology buses using clean diesel have criteria pollutant emission rates that are nearly the same as CNG buses.

Table IV-17. Annual Emission Changes in 2018 for DFW Area from the Use of CNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	65,132	0.000	0.000	0.000	0.000	0.000
LDT12	71,441	-0.228	-12.858	-0.306	0.018	0.016
LDT34	151,043	-0.240	-14.404	-0.434	0.015	0.014
HDV2B	60,235	-0.049	-4.114	0.267	-0.002	-0.002
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	13,169	0.000	0.000	0.000	0.000	0.000
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	3,135	0.000	0.000	0.000	0.000	0.000
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	6,093,135	0.000	0.000	4.685	0.106	0.098
School Bus	24,555	0.000	0.000	0.261	0.009	0.008
Total	**6,481,844**	**-0.518**	**-31.375**	**4.473**	**0.146**	**0.134**

Table IV-18 shows that the annual NO_x emission reduction benefit of expected LPG use by motor vehicles in the DFW area is 34 tons per year – with benefits for PM around 0.3 tons per year. The 2010 emission benefits are lower than in 2010 despite expected increases in LPG usage in vehicles because modern technology vehicles have negligible emission benefits for LPG versus conventional diesel. However, VOC and CO emissions are expected to increase by about 8 and 136 tons per year, respectively, in 2018. This is due to the use of gasoline vehicles as the baseline for the estimation of emission rates for all LPG vehicles.

Estimates of the annual emission reductions expected to occur in 2018 in HGB are shown in Table IV-19 for CNG, Table IV-20 for LNG, and Table IV-21 for LPG. The CNG fuel volumes in HGB in 2018 are expected to be slightly higher than in 2010, but the emission benefit is modest. Changes in emissions are only seen with the light-duty vehicles in 2018, with increases expected in VOC, CO, and NO_x. Again, these increases occur due to the use of a gasoline baseline for deriving the alternate fuel emission rates, and then comparing the resulting rates to those from diesel vehicles. HGB area LNG volumes in 2018 are lower than estimated for 2010, so emission reductions associated with LNG use (in medium-duty truck applications) are modest – about 0.3 tons of NO_x reduced per year. The greatest fuel volumes in the HGB area in 2018 are estimated to be from LPG. The use of this fuel results in a 24 ton per year decrease in NO_x

emissions, and about a half ton per year reduction in PM emissions. However, VOC and CO emissions are expected to increase, again because of the use of a gasoline baseline for all vehicle types for estimating the base LPG emission rates.

The alternative fuels expected to be used in the BPA area in 2018 are CNG and LPG, with volumes nearly the same as in 2009. As in 2010, no emission changes are seen from the use of CNG in BPA, as shown in Table IV-22. This is because all of the CNG use is by new model year transit buses, with emission rates comparable to diesel buses. The emission benefit from LPG, as shown in Table IV-23, is less than one-half of the 2010 NO_x benefit due to the negligible emission differences in newer vehicle emission rates.

Table IV-18. Annual Emission Changes in 2018 for DFW Area from the Use of LPG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	22,363	-0.164	-1.992	-0.045	0.012	0.011
LDT12	857	-0.012	-0.095	-0.004	0.000	0.000
LDT34	20,567	-0.080	-1.357	-0.029	0.005	0.005
HDV2B	279,367	-0.518	-15.756	0.903	0.014	0.012
HDV3	53,594	-0.116	-3.366	0.248	0.004	0.003
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	13,926	-0.063	-0.754	0.134	0.002	0.002
HDV6	64,060	-0.137	-4.116	0.504	0.013	0.012
HDV7	22,098	-0.033	-1.392	0.242	0.004	0.004
HDV8a	19,111	-0.079	-1.086	0.386	0.007	0.006
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	1,801,038	-7.134	-98.482	29.522	0.217	0.219
School Bus	133,446	-0.059	-7.933	1.718	0.028	0.027
Total	**2,430,426**	**-8.394**	**-136.330**	**33.579**	**0.307**	**0.303**

Table IV-19. Annual Emission Changes in 2018 for HGB Area from the Use of CNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	5,557	-0.008	-0.395	-0.009	0.001	0.001
LDT12	32,589	-0.043	-2.562	-0.053	0.004	0.004
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	77,520	0.000	0.000	0.000	0.000	0.000
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	0	0.000	0.000	0.000	0.000	0.000
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**115,666**	**-0.051**	**-2.957**	**-0.062**	**0.005**	**0.005**

Table IV-20. Annual Emission Changes in 2018 for HGB Area from the Use of LNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	0	0.000	0.000	0.000	0.000	0.000
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	6,548	0.000	0.015	0.033	0.001	0.001
HDV4	6,548	0.000	0.017	0.038	0.001	0.001
HDV5	6,548	0.000	0.029	0.066	0.002	0.002
HDV6	6,548	0.000	0.017	0.027	0.002	0.002
HDV7	6,548	0.000	0.023	0.035	0.002	0.002
HDV8a	6,548	0.000	0.041	0.068	0.003	0.003
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	0	0.000	0.000	0.000	0.000	0.000
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**39,286**	**0.001**	**0.141**	**0.266**	**0.012**	**0.011**

Table IV-21. Annual Emission Changes in 2018 for HGB Area from the Use of LPG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	1,090	-0.008	-0.097	-0.002	0.001	0.001
LDT12	61	-0.001	-0.007	0.000	0.000	0.000
LDT34	1,474	-0.006	-0.097	-0.002	0.000	0.000
HDV2B	20,017	-0.037	-1.129	0.065	0.001	0.001
HDV3	5,141	-0.011	-0.323	0.024	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	9,664	-0.044	-0.524	0.093	0.001	0.001
HDV6	44,456	-0.095	-2.856	0.350	0.009	0.009
HDV7	12,087	-0.018	-0.761	0.132	0.002	0.002
HDV8a	10,454	-0.043	-0.594	0.211	0.004	0.003
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	26,094	-0.045	-1.547	0.341	0.002	0.002
School Bus	1,418,620	-3.297	-77.600	23.012	0.441	0.422
Total	**1,549,158**	**-3.605**	**-85.536**	**24.223**	**0.462**	**0.441**

Table IV-22. Annual Emission Changes in 2018 for BPA Area from the Use of CNG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	0	0.000	0.000	0.000	0.000	0.000
LDT34	0	0.000	0.000	0.000	0.000	0.000
HDV2B	0	0.000	0.000	0.000	0.000	0.000
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	0	0.000	0.000	0.000	0.000	0.000
HDV6	0	0.000	0.000	0.000	0.000	0.000

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	209,167	0.000	0.000	0.000	0.000	0.000
School Bus	0	0.000	0.000	0.000	0.000	0.000
Total	**209,167**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Table IV-23. Annual Emission Changes in 2018 for BPA Area from the Use of LPG

		Annual Tons Reduction				
Vehicle	**Annual DGE**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
LDV	0	0.000	0.000	0.000	0.000	0.000
LDT12	17	0.000	-0.002	0.000	0.000	0.000
LDT34	410	-0.002	-0.027	-0.001	0.000	0.000
HDV2B	5,567	-0.010	-0.314	0.018	0.000	0.000
HDV3	0	0.000	0.000	0.000	0.000	0.000
HDV4	0	0.000	0.000	0.000	0.000	0.000
HDV5	239	-0.001	-0.013	0.002	0.000	0.000
HDV6	1,101	-0.002	-0.071	0.009	0.000	0.000
HDV7	0	0.000	0.000	0.000	0.000	0.000
HDV8a	0	0.000	0.000	0.000	0.000	0.000
HDV8b	0	0.000	0.000	0.000	0.000	0.000
Transit Bus	364	-0.001	-0.022	0.005	0.000	0.000
School Bus	32,810	-0.076	-1.795	0.532	0.010	0.010
Total	**40,508**	**-0.092**	**-2.243**	**0.565**	**0.011**	**0.010**

Table IV-24 summarizes the 2010 and 2018 emission results by geographic area and alternative fuel on a daily basis. The annual fuel volumes and emissions from Tables IV-9 through IV-23 were divided by 365 to estimate daily fuel volumes and emission changes.

Table IV-24. Summary of Estimated Daily Emission Reductions by Area and Fuel Type

	Nonattainment	Alternate	Daily Diesel	Daily Emission Reduction (tons)				
Year	**Area**	**Fuel**	**Gallon Equivalent**	**VOC**	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**
2010	DFW	CNG	6,502	0.0055	-0.0507	0.1806	0.0047	0.0044
		LNG	11,257	0.0117	0.1612	0.1479	0.0072	0.0066
		LPG	5,245	-0.0277	-0.1675	0.1600	0.0102	0.0096
		Total	23,003	-0.0105	-0.0569	0.4884	0.0221	0.0206
	HGB	CNG	255	0.0000	-0.0034	0.0020	0.0002	0.0002
		LNG	376	0.0000	0.0041	0.0074	0.0005	0.0004
		LPG	974	-0.0042	-0.0331	0.0301	0.0027	0.0025
		Total	1,605	-0.0042	-0.0324	0.0395	0.0034	0.0032
	BPA	CNG	579	0.0000	0.0000	0.0000	0.0000	0.0000
		LNG	0	0	0	0	0	0
		LPG	112	-0.0005	-0.0039	0.0033	0.0004	0.0003
		Total	691	-0.0005	-0.0039	0.0033	0.0004	0.0003
	Total	CNG	7,335	0.0054	-0.0541	0.1825	0.0050	0.0046
		LNG	11,633	0.0117	0.1653	0.1552	0.0077	0.0071
		LPG	6,331	-0.0324	-0.2045	0.1934	0.0133	0.0125
		Total	25,299	-0.0152	-0.0933	0.5312	0.0259	0.0242
2018	DFW	CNG	17,758	-0.0014	-0.0860	0.0123	0.0004	0.0004

Year	Nonattainment Area	Alternate Fuel	Daily Diesel Gallon Equivalent	Daily Emission Reduction (tons) VOC	CO	NO_x	PM_{10}	$PM_{2.5}$
		LNG	0	0	0	0	0	0
		LPG	6,659	-0.0230	-0.3735	0.0920	0.0008	0.0008
		Total	24,417	-0.0244	-0.4595	0.1042	0.0012	0.0012
	HGB	CNG	317	-0.0001	-0.0081	-0.0002	0.0000	0.0000
		LNG	108	0.0000	0.0004	0.0007	0.0000	0.0000
		LPG	4,244	-0.0099	-0.2343	0.0664	0.0013	0.0012
		Total	4,669	-0.0100	-0.2421	0.0669	0.0013	0.0013
	BPA	CNG	573	0.0000	0.0000	0.0000	0.0000	0.0000
		LNG	0	0	0	0	0	0
		LPG	111	-0.0003	-0.0061	0.0015	0.0000	0.0000
		Total	684	-0.0003	-0.0061	0.0015	0.0000	0.0000
	Total	CNG	18,648	-0.0016	-0.0941	0.0121	0.0004	0.0004
		LNG	108	0.0000	0.0004	0.0007	0.0000	0.0000
		LPG	11,014	-0.0331	-0.6140	0.1599	0.0021	0.0021
		Total	29,770	-0.0347	-0.7077	0.1727	0.0026	0.0025

3. Emission Reduction Benefits by Alternative Fuel Fueling Facility

This section provides an analysis of the estimated emission reduction benefit for each criteria pollutant that is fairly attributable to the installation of an alternative fuel fueling facility located in the ozone nonattainment areas. Table IV-25 summarizes the results of this analysis for 2010.

Clean Energy provided an estimate of CNG and LNG fuel sales at all of the Clean Energy stations, which included all of the LNG stations in the nonattainment areas, and most of the CNG stations as well. There are three stations (one in each of the nonattainment areas) that distribute CNG which are not owned by Clean Energy. Fuel sales data was acquired by contacting these three stations directly. Based on this information, quantities of fuel sold were allocated to all of the CNG and LNG stations in the three nonattainment areas.

Emissions reductions were then allocated to each station based on the quantities of fuel sold. In some cases, information on the vehicle type was also available, because some stations serve only transit buses. For example, all of the CNG fuel sold to Fort Worth Transportation Authority was used to fuel CNG buses, and therefore all of the emissions reductions associated with this station are based on transit buses using CNG. For stations where there is no specific information on the types of vehicles using natural gas, then the emissions savings in Table IV-25 were estimated based on the allocation of alternative fuel consumption by vehicle in the area.

LPG fuel sales are distributed based on total emissions reductions per nonattainment area divided by the number of LPG stations that provide vehicle fueling.

Table IV-25 shows the estimated fuel consumption at each station in DGE, followed by the emissions savings that are estimated to result from this fuel consumption. The fuel sold and savings predicted for LPG stations are an average for all LPG stations. Total LPG fuel consumption in each area can be calculated by multiplying the savings seen in Table IV-25 with the number of stations. All other stations show the fuel sales and emissions reduction attributable to that individual location. No distinction was made between the two DART LNG stations, and it is assumed that they each sell an equal share of DART's 4.1 million GDE of LNG.

Table IV-25. Summary Annual Emission Changes in 2010 from Alternate Fuel Use by Fueling Facility

Area	Fuel Type	Fueling Facility Name	Fuel Sold - DGE	Reduction in Annual Emissions (Tons) per Fueling Facility				
				VOC	CO	NO_x	PM_{10}	$PM_{2.5}$
DFW	CNG	Clean Energy - Cockrell Hill	56,247	0.05	-0.46	1.55	0.04	0.04
		Clean Energy - Downtown Dallas	104,881	0.09	-0.86	2.89	0.08	0.07
		Clean Energy - Central Service Center	248,781	0.22	-2.04	6.85	0.18	0.17
		Clean Energy - South Dallas	112,003	0.10	-0.92	3.09	0.08	0.08
		Clean Energy - Dallas/Fort Worth Airport South	1,505,421	1.33	-12.37	41.47	1.11	1.03
		Clean Energy - Garland	56,815	0.05	-0.47	1.57	0.04	0.04
		Clean Energy - Fort Worth	18,774	0.02	-0.15	0.52	0.01	0.01
		Clean Energy - City of Irving	14,170	0.01	-0.12	0.39	0.01	0.01
		Clean Energy - Love Field	132,812	0.12	-1.09	3.66	0.10	0.09
		Fort Worth Transportation Authority - The T	123,200	0	0	3.92	0.07	0.06
	LNG	Clean Energy - DART South Oak Cliff Division	2,054,388	2.14	29.42	26.98	1.32	1.21
		Clean Energy - DART Northwest Division	2,054,388	2.14	29.42	26.98	1.32	1.21
	LPG	No data available for each specific facility: identical contribution assumed for all 74 facilities	25,870	-0.14	-0.83	0.79	0.05	0.05
HGB	CNG	City of Lake Jackson	79,200	-0.0041	-1.06	0.62	0.07	0.07
		Clean Energy - Washington Ave	9,793	-0.0005	-0.131	0.076	0.009	0.008
		Clean Energy - McCarty Road	4,002	-0.0002	-0.054	0.031	0.004	0.003
	LNG	Clean Energy - HEB	98,043	0.0048	1.06	1.92	0.12	0.11
		Clean Energy - SYSCO Food Service	39,286	0.0019	0.43	0.77	0.05	0.05
	LPG	No data available for each specific facility: identical contribution assumed for all 84 facilities	4,233	-0.02	-0.14	0.13	0.01	0.01
BPA	CNG	Beaumont Municipal Transit System	211,200	0	0	0	0	0
	LPG	No data available for each specific facility: identical contribution assumed for all 11 facilities	3,718	-0.02	-0.13	0.11	0.01	0.01

Table IV-26 on the following page provides the analysis of the estimated emission reduction benefit for each criteria pollutant that is fairly attributable to the installation of an alternative fuel fueling facility located in the ozone nonattainment areas based on 2018 expected fuel sales. The number of fueling stations in the 2018 table is unchanged from the 2010 estimates.

4. Correlation Analysis

This report section examines whether the data collected in Task 3 determines a correlation between the installation of alternative fuel fueling facilities and the deployment of alternative fueled fleet vehicles. Certainly the expectation would be that fleets would be unlikely to purchase alternative fueled vehicles if fuel was not available locally to re-fuel those vehicles. Table IV-27 below shows the number of fueling facilities by area and fuel type along with the 2009 consumption of those fuels. While there is certainly a correlation between fuel availability and fuel use in these areas, the correlation is not straightforward and differs by fuel type and whether the transit agencies in each area have a dedicated fueling site for their bus fleets. Observations by fuel type are provided below.

Table IV-27. Total 2009 Alternative Fuel Consumption in Texas Ozone Nonattainment Areas (Diesel Gallon Equivalent)

	DFW		HGB		BPA	
	Number of Facilities	**Fuel Quantities**	**Number of Facilities**	**Fuel Quantities**	**Number of Facilities**	**Fuel Quantities**
LPG	74	1,914,368	84	355,599	11	40,901
CNG	10	2,373,104	3	92,995	1	211,200
LNG	2	4,108,776	2	137,329	0	0
Total	**86**	**8,396,248**	**89**	**585,923**	**12**	**252,101**

1. LPG/propane – because propane is used in many applications besides as a motor vehicle fuel, it is available at more sites than the other alternative fuels studied. Almost 75 percent of the LPG use in the DFW area is by transit buses, so non-transit fleets have enough fueling facilities in the study areas that fuel availability is likely not a deterrent to purchasing and using LPG in its fleet vehicles. There is limited transit bus use of LPG in HGB and BPA, so the number of facilities offering LPG for sale is sufficient to meet demand from motor vehicle fleets.

2. CNG – because the BPA CNG fueling station began dispensing CNG during calendar year 2009, there is limited evidence for assessing the correlation between CNG facilities and fleet using this fuel. In essence, there are two data points for CNG – DFW and HGB. With 10 CNG fueling facilities, DFW has more than an order of magnitude more CNG usage during 2009 than the HGB area does with 2 fueling facilities. Note, though, that the DFW area CNG usage is dominated by sales at two dedicated fueling stations – the ones that serve the Fort Worth Transit Authority and the DFW airport. If those sites are removed from the correlation analysis, the per station usage in DFW and HGB for CNG

Table IV-26. Fueling Station Estimate - 2018

Area	Fuel Type	Fueling Facility Name	Fuel Sold per Facility - DGE	Reduction in Annual Emissions (Tons) per Fueling Facility				
				VOC	CO	NO_x	PM_{10}	$PM_{2.5}$
DFW	CNG	Clean Energy - Cockrell Hill	56,247	-0.01	-0.78	0.03	0.002	0.002
		Clean Energy - Downtown Dallas	104,881	-0.02	-1.46	0.06	0.003	0.003
		Clean Energy - Central Service Center	248,781	-0.06	-3.47	0.13	0.01	0.01
		Clean Energy - South Dallas	112,003	-0.03	-1.56	0.06	0.004	0.003
		Clean Energy - Dallas/Fort Worth Airport South	1,505,421	-0.35	-20.99	0.82	0.05	0.04
		Clean Energy – Garland	56,815	-0.01	-0.79	0.03	0.002	0.002
		Clean Energy - Fort Worth	18,774	0.00	-0.26	0.01	0.001	0.001
		Clean Energy - City of Irving	14,170	0.00	-0.20	0.01	0.0005	0.0004
		Clean Energy - Love Field	132,812	-0.03	-1.85	0.07	0.004	0.004
		Clean Energy - DART Northwest Division	2,054,388	0	0	1.58	0.04	0.03
		Clean Energy - DART South Oak Cliff Division	2,054,388	0	0	1.58	0.04	0.03
		Fort Worth Transportation Authority - The T	123,200	0	0	0.095	0.002	0.002
	LPG	No data available for each specific facility: identical contribution assumed for all 74 facilities	32,844	-0.113	-1.84	0.45	0.0041	0.0041
HGB	CNG	City of Lake Jackson	98,508	-0.0434	-2.52	-0.05	0.005	0.004
		Clean Energy - Washington Ave	12,180	-0.0054	-0.311	-0.007	0.001	0.001
		Clean Energy - McCarty Road	4,978	-0.0022	-0.127	-0.003	0.0002	0.0002
	LNG	Clean Energy - SYSCO Food Service	39,286	0.0007	0.14	0.27	0.01	0.01
	LPG	No data available for each specific facility: identical contribution assumed for all 84 facilities	18,442	-0.043	-1.02	0.29	0.005	0.005
BPA	CNG	Beaumont Municipal Transit System	209,167	0	0	0	0	0
	LPG	No data available for each specific facility: identical contribution assumed for all 11 facilities	3,683	-0.0084	-0.20	0.05	0.0010	0.0009

are more nearly the same per fueling facility. The fueling facility data minus the dedicated fueling sites is shown in Table IV-28.

Table IV-28. Fueling Stations Serving Public Fleets (Diesel Gallon Equivalent)

	DFW		HGB		BPA	
	Number of Facilities	**Fuel Quantities**	**Number of Facilities**	**Fuel Quantities**	**Number of Facilities**	**Fuel Quantities**
LPG	74	1,914,368	84	355,599	11	40,901
CNG	8	744,483	2	13,795	0	0
LNG	0	0	2	137,329	0	0
Total	**82**	**2,658,851**	**88**	**506,723**	**11**	**40,901**

3. LNG – it is difficult to develop conclusions about correlations between fueling stations and LNG usage because the DFW LNG sites are dedicated to fueling DART buses. Because these are dedicated sites, they deliver 30 times the LNG that the sites in HGB delivered in 2009. In summary, the sample size for LNG stations is too small to develop correlations.

CHAPTER V. RECOMMENDATIONS

One of the most critical variables in estimating alternative fuel associated emission reductions in the future is whether vehicles that use propane, CNG, or LNG as their primary fuel have any observed emission differences from a diesel-powered vehicle that meets either Tier 2 light-duty vehicle or the 2007 plus model year heavy-duty diesel vehicle emission standards. Based on the evidence available now, it has been estimated that the current EPA emission standards are stringent enough that diesel and alternative fueled-vehicle emission rates are the same. There is not enough information available from certification tests, or other research studies, to support a different modeling assumption.

A recent paper in the *Journal of the Air & Waste Management Association* provides some examples of the types of data that would be useful for quantitative evaluations of the emission benefits of using alternative fuels in modern technology vehicles (Zhai, et al., 2009). This paper examined tailpipe emissions of flexible fuel vehicles operated on ethanol 85 (E85) versus gasoline. Emissions data available for this analysis included a portable emissions measurement system, cycle average dynamometer emission test results, and emissions certification test results. While ethanol is not of interest in Texas, the types of emission data available for E85 provide examples of what would be useful to have for the primary alternative fuels being used as a motor vehicle fuel in Texas.

If Texas gets more school districts involved in the propane school bus program, it would be useful to have a centralized database that retains information on school bus ages (model years), primary fuel, and annual miles driven. Currently, the RRC of Texas just retains information on numbers of school buses by school district (and county).

The data provided by the Texas Comptroller of Public Accounts was a critical information source for estimating alternative fuel use for non-exempt vehicles in Texas. Non-exempt means that the user pays an annual tax on each motor vehicle using liquefied gas that is owned, operated, and licensed in Texas based on the registered gross vehicle weight and mileage driven the previous year. The Texas Comptroller of Public Accounts data would be even more useful than it currently is if this organization tracked and reported the model year of each non-exempt vehicle.

One of the premises of this study is that alternative fueled vehicles in the study area replace diesel vehicles. This premise is based on the assumption that alternative-fueled vehicles are largely used by fleets. Because most of the data collected on vehicles and fuel use was not collected directly from fleets, this premise was not confirmed. It seems unlikely that all of the light-duty vehicle applications were diesel-powered vehicles prior to alternative fuel use because there are only a few diesel passenger cars available currently.

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Zhai, et al., 2009: Zhai, H., C. Frey, N.M. Rouphail, G.A. Goncalves, and T.L. Farias, "Comparison of Flexible Fuel Vehicle and Life-Cycle Fuel Consumption and Emissions of Selected Pollutants and Greenhouse Gases for Ethanol 85 Versus Gasoline," *Journal of the Air & Waste Management Association*, **59**:912-924, August 2009.

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APPENDIX A: COMPTROLLER DATA

The tables in Appendix A summarize the data provided by the Texas Comptroller of Public Accounts on non-exempt vehicles that were currently registered in specific Texas counties by class. This information was available because a user of liquefied gas for the propulsion of a motor vehicle on the public highways of the state pays a tax in advance annually on each motor vehicle owned, operated, and licensed in Texas based on the registered gross vehicle weight and mileage driven the previous year in the following schedule. Weight class T vehicles are transit buses:

Vehicle Class	Annual Miles Driven			
	1	2	3	4
	Less than 5,000 miles	5,000 to 9,999 miles	10,000 to 14,999 miles	15,000 miles and over
Class A: Less than 4,000 lbs	$ 30	$ 60	$ 90	$120
Class B: 4,001 to 10,000 lbs	$ 42	$ 84	$126	$168
Class C: 10,001 to 15,000 lbs	$ 48	$ 96	$144	$192
Class D: 15,001 to 27,500 lbs	$ 84	$168	$252	$336
Class E: 27,501 to 43,500 lbs	$126	$252	$378	$504
Class F: 43,501 lbs and over	$186	$372	$558	$744

Table A-1. Alternative Fueled Vehicles in DFW Counties

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
COLLIN	LPG	A	2	1
COLLIN	LPG	B	1	9
COLLIN	LPG	B	2	4
COLLIN	LPG	B	3	5
COLLIN	LPG	B	4	3
COLLIN	LPG	C	2	1
COLLIN	LPG	D	1	6
COLLIN	LPG	E	1	1
COLLIN	LPG	E	2	1
COLLIN	LPG	E	4	1
DALLAS	LPG	A	1	15
DALLAS	LPG	A	2	14
DALLAS	LPG	A	3	7
DALLAS	LPG	A	4	8
DALLAS	LPG	B	1	46
DALLAS	LPG	B	2	27
DALLAS	LPG	B	3	12
DALLAS	LPG	B	4	17
DALLAS	LPG	C	1	22
DALLAS	LPG	C	2	4

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
DALLAS	LPG	C	3	8
DALLAS	LPG	C	4	7
DALLAS	LPG	D	1	7
DALLAS	LPG	D	2	2
DALLAS	LPG	D	3	3
DALLAS	LPG	D	4	5
DALLAS	LPG	E	1	2
DALLAS	LPG	E	2	2
DALLAS	LPG	E	4	4
DALLAS	LPG	T	1	1
DALLAS	LPG	T	4	21
DALLAS	CNG	A	1	199
DALLAS	CNG	A	2	85
DALLAS	CNG	A	3	33
DALLAS	CNG	A	4	27
DALLAS	CNG	B	1	351
DALLAS	CNG	B	2	312
DALLAS	CNG	B	3	160
DALLAS	CNG	B	4	237
DALLAS	CNG	C	1	8
DALLAS	CNG	C	2	6
DALLAS	CNG	C	3	7
DALLAS	CNG	C	4	36
DALLAS	CNG	D	1	12
DALLAS	CNG	D	2	15
DALLAS	CNG	D	3	19
DALLAS	CNG	D	4	31
DALLAS	CNG	E	1	14
DALLAS	CNG	E	3	1
DALLAS	CNG	E	4	45
DALLAS	CNG	F	1	6
DALLAS	CNG	T	4	5
DALLAS	LNG	B	1	1
DALLAS	LNG	C	1	2
DALLAS	LNG	D	4	3
DALLAS	LNG	T	4	155
DENTON	LPG	A	1	1
DENTON	LPG	A	2	1
DENTON	LPG	B	1	19
DENTON	LPG	B	2	4
DENTON	LPG	C	1	1

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
DENTON	LPG	D	1	4
DENTON	LPG	D	2	2
DENTON	LPG	E	1	1
DENTON	LPG	E	4	1
DENTON	LNG	F	4	7
ELLIS	LPG	B	1	3
ELLIS	LPG	B	2	1
ELLIS	LPG	B	3	2
ELLIS	LPG	D	2	1
ELLIS	LPG	E	1	1
ELLIS	CNG	B	2	1
JOHNSON	LPG	B	1	3
JOHNSON	LPG	B	2	2
JOHNSON	LPG	B	3	3
JOHNSON	LPG	D	1	1
JOHNSON	LPG	D	4	2
JOHNSON	LPG	T	1	1
JOHNSON	LPG	T	4	4
KAUFMAN	LPG	B	1	11
KAUFMAN	LPG	B	2	4
KAUFMAN	LPG	B	3	2
KAUFMAN	LPG	B	4	1
KAUFMAN	LPG	C	1	9
KAUFMAN	LPG	C	2	1
KAUFMAN	LPG	C	4	1
KAUFMAN	LPG	D	1	16
KAUFMAN	LPG	D	2	11
KAUFMAN	LPG	D	4	3
KAUFMAN	LPG	E	1	3
KAUFMAN	LPG	E	2	5
KAUFMAN	LPG	E	3	2
KAUFMAN	LPG	E	4	1
KAUFMAN	LPG	T	1	2
KAUFMAN	LPG	T	2	1
KAUFMAN	LPG	T	4	7
KAUFMAN	CNG	T	3	1
KAUFMAN	CNG	T	4	3
PARKER	LPG	B	1	10
PARKER	LPG	B	2	3
PARKER	LPG	B	3	1
PARKER	LPG	B	4	2

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
PARKER	LPG	D	1	6
PARKER	LPG	D	2	1
ROCKWALL	LPG	B	4	3
TARRANT	LPG	A	1	11
TARRANT	LPG	A	2	6
TARRANT	LPG	A	3	2
TARRANT	LPG	B	1	114
TARRANT	LPG	B	2	77
TARRANT	LPG	B	3	44
TARRANT	LPG	B	4	71
TARRANT	LPG	C	1	4
TARRANT	LPG	C	2	2
TARRANT	LPG	D	1	1
TARRANT	LPG	D	2	4
TARRANT	LPG	D	3	2
TARRANT	LPG	D	4	4
TARRANT	LPG	E	1	2
TARRANT	LPG	E	2	1
TARRANT	LPG	E	3	1
TARRANT	LPG	E	4	1
TARRANT	LPG	T	1	1
TARRANT	LPG	T	2	2
TARRANT	LPG	T	3	4
TARRANT	LPG	T	4	4
TARRANT	CNG	A	4	1
TARRANT	CNG	B	1	6
TARRANT	CNG	B	2	2
TARRANT	CNG	B	3	3
TARRANT	CNG	B	4	1
TARRANT	CNG	C	1	1
TARRANT	CNG	T	1	11
TARRANT	CNG	T	2	4
TARRANT	CNG	T	3	5
TARRANT	CNG	T	4	157
TARRANT	CNG	Z	1	5
TARRANT	LNG	B	1	1

Table A-2. Alternative Fueled Vehicles in HGB Counties

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
BRAZORIA	LPG	B	1	1
BRAZORIA	LPG	B	2	1
BRAZORIA	LPG	B	4	1
BRAZORIA	LPG	C	3	1
BRAZORIA	LPG	D	1	3
BRAZORIA	LPG	D	2	1
BRAZORIA	LPG	D	3	2
BRAZORIA	LPG	D	4	1
BRAZORIA	LPG	E	1	1
BRAZORIA	LPG	E	4	1
BRAZORIA	CNG	A	1	3
BRAZORIA	CNG	A	4	2
BRAZORIA	CNG	B	4	12
BRAZORIA	CNG	F	2	5
BRAZORIA	CNG	F	3	2
BRAZORIA	CNG	F	4	6
BRAZORIA	LNG	C	1	1
FORT BEND	LPG	B	1	3
FORT BEND	LPG	B	2	1
FORT BEND	LPG	D	2	1
FORT BEND	LPG	E	2	2
GALVESTON	LPG	B	1	8
GALVESTON	LPG	B	2	2
GALVESTON	LPG	C	1	1
GALVESTON	LPG	C	2	1
GALVESTON	LPG	D	1	2
GALVESTON	LPG	D	3	3
GALVESTON	LPG	E	4	1
GALVESTON	LPG	T	1	3
GALVESTON	LPG	T	2	3
GALVESTON	LPG	T	3	2
GALVESTON	LPG	T	4	7
HARRIS	LPG	A	1	2
HARRIS	LPG	A	2	1
HARRIS	LPG	A	4	1
HARRIS	LPG	B	1	23
HARRIS	LPG	B	2	4
HARRIS	LPG	B	3	4
HARRIS	LPG	B	4	3

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
HARRIS	LPG	C	2	1
HARRIS	LPG	D	1	7
HARRIS	LPG	D	2	3
HARRIS	LPG	D	3	5
HARRIS	LPG	E	1	2
HARRIS	LPG	E	2	2
HARRIS	LPG	E	3	2
HARRIS	CNG	B	1	9
HARRIS	CNG	B	2	16
HARRIS	CNG	B	3	17
HARRIS	CNG	B	4	18
LIBERTY	LPG	B	1	3
LIBERTY	LPG	B	2	2
LIBERTY	LPG	D	1	3
LIBERTY	LPG	D	3	1
LIBERTY	LPG	D	4	2
LIBERTY	LPG	E	2	1
LIBERTY	LPG	E	4	1
MONTGOMERY	LPG	B	1	4
MONTGOMERY	LPG	B	2	2
MONTGOMERY	LPG	B	3	2
MONTGOMERY	LPG	B	4	1
MONTGOMERY	LPG	C	4	1
MONTGOMERY	LPG	D	1	2
MONTGOMERY	LPG	D	2	1
MONTGOMERY	LPG	D	3	1
MONTGOMERY	LPG	D	4	10
MONTGOMERY	LPG	E	1	2
MONTGOMERY	LPG	E	2	4
MONTGOMERY	LPG	E	4	1
WALLER	LPG	B	2	1
WALLER	LPG	D	4	2
WALLER	LPG	E	3	1

Table A-3. Alternative Fueled Vehicles in BPA Counties

COUNTY	FUEL TYPE	WEIGHT CLASS	ANNUAL MILEAGE	NUMBER OF VEHICLES
JEFFERSON	LPG	B	1	2
JEFFERSON	LPG	B	2	4
JEFFERSON	LPG	B	3	4
JEFFERSON	LPG	B	4	1
JEFFERSON	LPG	D	3	1
JEFFERSON	LPG	T	1	1
JEFFERSON	CNG	A	2	2
JEFFERSON	CNG	T	1	1

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APPENDIX B: NCTCOG DATA

Entity	Fuel System	Fuel Type	GVWR	Percent NG Use	Model Year	Miles Driven with CNG Power
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	1999	244,379
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2000	1,224,684
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2001	774,589
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2002	913,308
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2003	1,720,868
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2004	801,918
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2005	306,784
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2006	373,083
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2007	293,120
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2008	6,876
All DFW	Dedicated	CNG	A (up to 6000 lbs)	1	2009	1,756
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	1997	398,201
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	1998	118,922
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	1999	542,840
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	2000	898,230
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	2001	627,806
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	2002	926,717
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	2003	293,885
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	2004	54,535
All DFW	Dedicated	CNG	B (6001-8500 lbs)	1	2008	3,298
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	1997	2,304
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	1999	39,200
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	2000	227,224
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	2001	49,862
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	2002	505,626
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	2003	51,051
All DFW	Dedicated	CNG	C (8501-10000 lbs)	1	2004	299,604
All DFW	Dedicated	CNG	E (14001-16000 lbs)	1	2004	202,158
All DFW	Dedicated	CNG	G (19501-26000 lbs)	1	2003	41,089
All DFW	Dedicated	CNG	School Bus	1	2008	9,963
All DFW	Dedicated	CNG	Transit Bus	1	1992	47,000
All DFW	Dedicated	CNG	Transit Bus	1	1995	285,000
All DFW	Dedicated	CNG	Transit Bus	1	2000	1,177,179
All DFW	Dedicated	CNG	Transit Bus	1	2001	60,000
All DFW	Dedicated	CNG	Transit Bus	1	2002	2,530,000
All DFW	Dedicated	CNG	Transit Bus	1	2003	436,088
All DFW	Dedicated	CNG	Transit Bus	1	2004	1,598,314
All DFW	Dedicated	CNG	Transit Bus	1	2005	2,343,479
All DFW	Dedicated	CNG	Transit Bus	1	2006	2,015,447
All DFW	Dedicated	CNG	Transit Bus	1	2007	674,722
All DFW	Dedicated	CNG	Transit Bus	1	2008	973,766
All DFW	Dedicated	CNG	Transit Bus	1	2009	71,586
All DFW	Dedicated	LNG	Transit Bus	1	1998	8,004,576
All DFW	Dedicated	LNG	Transit Bus	1	2002	1,895,868
All DFW	Flex-Fuel/Bi-Fuel	CNG/Gasoline	A (up to 6000 lbs)	0.5	1992	46,025
All DFW	Flex-Fuel/Bi-Fuel	CNG/Gasoline	B (6001-8500 lbs)	0.5	1994	8,196.5
All DFW	Flex-Fuel/Bi-Fuel	CNG/Gasoline	B (6001-8500 lbs)	0.5	1997	3,363.5
All DFW	Flex-Fuel/Bi-Fuel	CNG/Gasoline	B (6001-8500 lbs)	0.77	2003	2,496.34
All DFW	Flex-Fuel/Bi-Fuel	CNG/Gasoline	C (8501-10000 lbs)	0.5	1995	2,983

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APPENDIX C: ALTERNATIVE FUEL LOCATIONS

Table C-1a. BPA Area CNG Stations

ID Number	Fuel Type	Station Name	Street Address	City	State	Zip	Phone	Status	Access
30623	Compressed Natural Gas	Beaumont Municipal Transit System	550 Milam Dr	Beaumont	TX	77701	432-694-0202	Existing	Public - credit card at all times

Table C-1b. HGB Area CNG Stations

ID Number	Fuel Type	Station Name	Street Address	City	State	Zip	Phone	Status	Access
72	Compressed Natural Gas	Clean Energy - Washington Ave	7721A Washington Ave	Houston	TX	77007	866-278-3674	Existing	Public - credit card at all times
333	Compressed Natural Gas	Clean Energy - McCarty Road	227 McCarty Rd	Houston	TX	77029	866-278-3674	Existing	Public - credit card at all times

Table C-2. HGB Area LNG Stations

ID Number	Fuel Type	Station Name	Street Address	City	State	Zip	Phone	Status	Access
33135	Liquefied Natural Gas	Clean Energy - HEB	4625 Windfern Road	Houston	TX	77041		Existing	Private access only

Table C-3. DFW Area CNG Stations

ID Number	Fuel Type	Station Name	Street Address	City	State	Zip	Phone	Status	Access
12767	Compressed Natural Gas	Clean Energy - Cockrell Hill	2005 Cockrell Hill Road	Dallas	TX	75211	866-278-3674	Existing	Public - credit card at all times
456	Compressed Natural Gas	Clean Energy - Downtown Dallas	100 N Industrial Boulevard	Dallas	TX	75207	866-278-3674	Existing	Public - credit card at all times
26654	Compressed Natural Gas	Clean Energy - Central Service Center	1551 Baylor Avenue	Dallas	TX	75226	866-278-3674	Existing	Public - credit card at all times
12768	Compressed Natural Gas	Clean Energy - South Dallas	3701 S Lamar Street	Dallas	TX	75215	866-278-3674	Existing	Public - credit card at all times
21975	Compressed Natural Gas	Clean Energy - Dallas/Fort Worth Airport South	2424 5E Employee Road	DFW Airport	TX	75261	866-278-3674	Existing	Public - credit card at all times
477	Compressed Natural Gas	Clean Energy - Garland	3526 Security Street	Garland	TX	75042	866-278-3674	Existing	Public - credit card at all times
1396	Compressed Natural Gas	Clean Energy - Fort Worth	4600 Mark IV Parkway	Fort Worth	TX	76161	866-278-3674	Existing	Public - credit card at all times
465	Compressed Natural Gas	Fort Worth Transportation Authority - The T	1600 E Lancaster Ave	Fort Worth	TX	76102		Existing	Private - government only
453	Compressed Natural Gas	Clean Energy - City of Irving	128 N Briery Road	Irving	TX	75061	866-278-3674	Existing	Public - credit card at all times
26655	Compressed Natural Gas	Clean Energy - Love Field	8000 Denton Drive	Dallas	TX	75235	866-278-3674	Existing	Public - credit card at all times

Table C-4. DFW Area LNG Stations

ID Number	Fuel Type	Station Name	Street Address	City	State	Zip	Phone	Status	Access
23490	Liquefied Natural Gas	Clean Energy - DART South Oak Cliff Division	3424 E Kiest Boulevard	Dallas	TX	75203	866-278-3674	Existing	Private - fleet customers only
33136	Liquefied Natural Gas	Clean Energy - SYSCO Food Service	800 Trinity Drive	Lewisville	TX	75056		Existing	Private access only
23489	Liquefied Natural Gas	Clean Energy - DART Northwest Division	2424 Webb Chapel Extention	Dallas	TX	75220	866-278-3674	Existing	Private - fleet customers only

Table C-5. Propane Retailers by County for DFW

Company	Street Address	City, State Zip
	COLLIN COUNTY	
AMERIGAS PROPANE	3670 N HWY 78	WYLIE, TX 75098
BRANCH GROCERY	JCT OF FM 546 & FM 3286	PRINCETON, TX 75407
COLLINS PROPANE	1445 E FM 544	WYLIE, TX 75098
LIGHTHOUSE RV RESORT	1020 US HWY 75 N	MELISSA, TX 75454
SECURE RV INC	1480 WEST US HWY 380	PROSPER, TX 75078
THURSTON'S	HWY 75 & PARKER RD	PLANO, TX 75074
U-HAUL	4101 W PLANO PKWY	PLANO, TX 75093
WYLIE BUTANE GAS CO	1001 S HWY 78	WYLIE, TX 75098
	DALLAS COUNTY	
HUFFHINES GAS CO	9323 S CENTRAL EXPWY	DALLAS, TX 75241
NORTHWEST PROPANE GAS CO	11551 HARRY HINES BLVD	DALLAS, TX 75229
AIRGAS SOUTHWEST	2780 IRVING BLVD	DALLAS, TX 75207
CITGO	103 S IH-45	WILMER, TX 75172
FLYING J TRUCK STOP	34100 LBJ FREEWAY IH-20	DALLAS, TX 75241
JACKSON'S POTTERY	6950 LEMMON AVE	DALLAS, TX 75209
LONGHORN SALES & LEASING	725 S JUPITER	GARLAND, TX 75042
PROGAS	294 SOUTH HWY 175	SEAGOVILLE, TX 75159
STEWART GAS	2316 N HWY 175	SEAGOVILLE, TX 75159
TRAYLOR MOTOR HOMES	480 N HWY 67	CEDAR HILL, TX 75104
U-HAUL	7015 FERGUSON RD	DALLAS, TX 75228
U-HAUL	9929 HARRY HINES	DALLAS, TX 75220
U-HAUL	7015 S THORNTON FRWY	DALLAS, TX 75232
UNITED WELDING	4344 IRVING BLVD	DALLAS, TX
ZIPPY PROPANE (U-HAUL CO)	1521 N HWY 67	CEDAR HILL, TX 75104
	DENTON COUNTY	
ENDERBY GAS	1019 S STEMMONS	SANGER, TX 76266
NORTHWEST PROPANE GAS CO	9001 FM 423	FRISCO, TX 75034
ARENTCO RENTAL & SALES	1204 N STEMMONS FRWY	LEWISVILLE, TX 75067
DALLAS KOA CAMPGROUND/DESTINY RV	7100 S IH-35 E	LAKE DALLAS, TX 76210
ENDERBY GAS	5549 MILLER RD	KRUM, TX 76249
GIERISCH BROS MOTOR CO	608 N PINE	ROANOKE, TX 76262
HAMPTON'S EXXON STATION	1293 HWY 377	PILOT POINT, TX 76258
HENDERSON OIL & BUTANE CO	401 N HWY 156 N	JUSTIN, TX 76247
MAY'S RV	1212 N STEMMONS FRWY	LEWISVILLE, TX 75067
NORTHWEST PROPANE GAS CO	277 S MILL ST	LEWISVILLE, TX 75067
	ELLIS COUNTY	
INDEPENDENT PROPANE	3675 HWY 287 E	MIDLOTHIAN, TX 76065
NELSON PUTMAN PROPANE	2505 N KAUFMAN	ENNIS, TX 75120

Company	Street Address	City, State Zip
FERRELLGAS	1814 W BUS 287	WAXAHACHIE, TX 75165
HILLTOP TRAVEL TRAILERS	850 W RED OAK RD	RED OAK, TX 75119
PEARMAN OIL & LP GAS	101 S HWY 77	WAXAHACHIE, TX 75165
JOHNSON COUNTY		
INDEPENDENT PROPANE	3111 NORTH MAIN	CLEBURNE, TX 76031
CLEBURNE PROPANE	1106 W KILPATRICK	CLEBURNE, TX 76033
GODFREY PROPANE CO	2103 S MAIN	CLEBURNE, TX 76031
MCCLAIN'S RV	7636 S IH-35 W	ALVARADO, TX 76009
GENE HARRIS PETROLEUM INC	12901 S FRWY	BURLESON, TX 76028
KAUFMAN COUNTY		
NORTHWEST PROPANE GAS CO	122 E HWY 80	FORNEY, TX
PENNY'S PROPANE	1425 E MULBERRY	KAUFMAN, TX 75142
AUTOMATIC GAS CO	290 FM 429 N	TERRELL, TX 75161
PENNY'S PROPANE	1252 E MAIN	GUNBARREL CITY, TX 75147
PARKER COUNTY		
TEXAS BUTANE GAS CO INC	103 W CHURCH ST	WEATHERFORD, TX 76086
CHADWELL & SON GAS CO	608 HWY 199 E	SPRINGTOWN, TX 76082
COWTOWN RV PARK	7000 IH-20 W	ALEDO, TX 76008
FERRELLGAS	3154 RANGER HWY	WEATHERFORD, TX 76088
VICK'S CHEVRON & PROPANE SERVICE	705 N MAIN	WEATHERFORD, TX 76086
WEATHERFORD/FORT WORTH KOA	2205 TIN TOP RD	WEATHERFORD, TX 76087
ROCKWALL COUNTY		
GAS-TEX	5940 STATE HWY 276	ROYSE CITY, TX 75189
FERRELLGAS	702 E IH-30	ROYSE CITY, TX 75189
TARRANT COUNTY		
AMERIGAS PROPANE	6801 MITCHELL PKWY	ARLINGTON, TX
GODFREY PROPANE GAS	2947 W DIVISION	ARLINGTON, TX 76012
PROPANE BOTTLE SERVICE CO	5216 JACKSBORO HWY	FORT WORTH, TX 76114
CHAPMAN PROPANE	2001 MONEDA SUITE A	HALTOM CITY, TX 76117
EATON ESTATES CAMPGROUNDS	1961 LONE STAR RD	MANSFIELD, TX 76063
JOE RIDER PROPANE	7808 JACKSBORO HWY	FORT WORTH, TX 76135
RURAL GAS SUPPLY	140 W MAIN	AZLE, TX 76020
AIRGAS SOUTHWEST	314 EXCHANGE DR	ARLINGTON, TX 76011
FORT WORTH BUTANE GAS CO	5828 E BELKNAP	FORT WORTH, TX 76117
HALL'S FARMER OUTLET	4200 GLADE RD	COLLEYVILLE, TX 76034
INDEPENDENT PROPANE	5620 JACKSBORO HWY	FORT WORTH, TX 76114
MANSFIELD GAS & EXHAUST CENTER	1304 N MAIN ST	MANSFIELD, TX 76063
MR C'S HARDWARE	1201 PRECINCT LINE RD	HURST, TX 76053
NORTH TEXAS PROPANE	8307 HWY 80 W	FORT WORTH, TX 76116
PROPANE SYSTEMS OF TEXAS	3101 AIRPORT FRWY	FORT WORTH, TX 76111
TREETOP'S RV VILLAGE	1901 W ARBROOK	ARLINGTON, TX 76015

Company	Street Address	City, State Zip
U-HAUL	2315 W DIVISION	ARLINGTON, TX 76012
U-HAUL	2936 S FRWY	FORT WORTH, TX 76104
U-HAUL	HWY 183 AT IH-30	FORT WORTH, TX 76114

Table C-6. Propane Retailers by County for HGB

Company	Street Address	City, State Zip
	BRAZORIA COUNTY	
BARTA BROTHERS	3623 LIVE OAK	DAMON, TX 77430
ALL STAR PROPANE	219 N TAYLOR	ALVIN, TX 77511
PROGAS ENERGY SERVICES	613 S AVE B	FREEPORT, TX 77541
BAYGAS	2906 MANVEL RD	PEARLAND, TX 77584
BRAZOS LANDSCAPING	2830 S VELASCO	ANGLETON, TX 77515
D&L PROPANE	1336 FM 521	BRAZORIA, TX 77422
GAS TEC	5070 N HIGHWAY 35	ALVIN, TX 77511
OYSTER CREEK RV RACH	2815 FM 523	OYSTER CREEK, TX 77541
SOUTHERN BUTANE	FM 521 W	BRAZORIA, TX 77422
STANTON'S SHOPPING CENTER	219 N TAYLOR	ALVIN, TX 77511
	CHAMBERS COUNTY	
GORE PROPANE	201 N ROSS STERLING	ANAHUAC, TX 77514
HILL BUTANE CO	HWY 124	STOWELL, TX 77661
INDEPENDENT PROPANE	10610 IH-10 E	MOUNT BELVIEU, TX 77580
TURTLE CREEK BAYOU RV PARK	25128 IH-10	WALLISVILLE, TX 77597
	FORT BEND COUNTY	
AZTEC RENTAL CENTER	11610 HWY 6 S	SUGAR LAND, TX 77478
COASTAL BUTANE SERVICE	3230 BAMORE	ROSENBERG, TX 77471
EDDIE'S GARAGE	8231 FM 360	NEEDVILLE, TX 77461
GULF COAST LP GAS CO	3201 FM 521	FRESNO, TX 77545
KATY BUTANE COMPANY	6803 HWY BLVD	KATY, TX 77494
MARIN PROPANE GAS INC	3702 - 5TH	MISSOURI CITY, TX 77459
AIRGAS SOUTHWEST	2103 HWY 90-A	MISSOURI CITY, TX 77489
	HARRIS COUNTY	
NORTHSIDE PROPANE	11404 EASTEX FRWY	HOUSTON, TX
PPL MOTOR HOMES	10777 HWY 59 (SOUTHWEST FRWY)	HOUSTON, TX 77074
A-B GAS COMPANY DBA A PLUS GAS CO	4722 W 18TH ST	HOUSTON, TX 77092
AAA LP GAS LTD	18402 STUEBNER-AIRLINE	SPRING, TX 77379
AIRGAS HOUSTON	510 ALDINE BENDER	HOUSTON, TX 77060
AMERIGAS PROPANE	8903 LAWNDALE	HOUSTON, TX 77012
BUD'S LP GAS & SUPPLIES	IH-10 AT DELLDALE	CHANNELVIEW, TX 77530
CY-FAIR PROPANE CO	23248 NORTHWEST FWY	CYPRESS, TX 77429
EAGLE GAS & SUPPLY	1201 HWY 146	SEABROOK, TX 77586
EASTEX CAMPER SALES	15422 EASTEX FRWY	HUMBLE, TX 77045
FLYING J TRUCK STOP	IH-45 RICHIE RD, EXIT 64	HOUSTON, TX 77090
GREEN'S BLUE FLAME GAS CO	13823 PACKARD	HOUSTON, TX 77040
HOP'S PROPANE & PERFORMANCE	16103 HWY 6	SANTA FE, TX 77517
HOUSTON LEISURE RV PARK	1601 S MAIN ST	HIGHLANDS, TX 77562
KOA HOUSTON E BAYTOWN RV PARK	11810 IH-10 E	BAYTOWN, TX 77520
MCADAMS PROPANE	3410 E END BLVD S	MARSHALL, TX 75670
MCADAMS PROPANE CO	HWY 96 N	CENTER, TX 75935
MCPEARSON U-HAUL	9901 FAIRMONT PKWY	LA PORTE, TX 77571
METROLIFT	11520 S PETROPARK	HOUSTON, TX 77041
PROFESSIONAL WELDING SUPPLY	3000 BRITTMORE #B	HOUSTON, TX 77043
TEXAS LAWNCARE PRODUCTS	14214 EASTEX FRWY	HUMBLE, TX 77396
TOMBALL TOOL	27219 FM 249	TOMBALL, TX 77375
TRADERS VILLAGE HOUSTON	7979 N ELDRIDGE	HOUSTON, TX 77041
U-HAUL CO OF HOUSTON	9411 FM 1960 W	HOUSTON, TX 77070

Company	Street Address	City, State Zip
U-HAUL CO OF HOUSTON	12455 VETERANS MEMORIAL	HOUSTON, TX 77014
U-HAUL CO OF HOUSTON	10621 S MAIN	HOUSTON, TX 77025
U-HAUL CO OF HOUSTON	13330 IH-10 E	HOUSTON, TX 77015
U-HAUL CO OF HOUSTON	5333 IH-45 N	HOUSTON, TX 77022
U-HAUL CO OF HOUSTON	6808 BISSONNET	HOUSTON, TX 77047
U-HAUL CO OF HOUSTON	10220 OLD KATY RD	HOUSTON, TX 77043
U-HAUL CO OF HOUSTON	16405 IH-45 N	HOUSTON, TX 77090
U-HAUL CO OF HOUSTON	3536 RED BLUFF	PASADENA, TX 77503
UNITED WELDING SUPPLY	1301 LATHROP	HOUSTON, TX 77020
VARCADOS EXXON	150 GESSNER RD UNIT 7C	HOUSTON, TX
WELD WORLD	2400 FM 2920	SPRING, TX 77388
	GALVESTON COUNTY	
A-1 RENTALS OF GALVESTON	2326 SKYMASTER	GALVESTON, TX 77554
BAY-TEC PROPANE SERVICE CO	4761 HWY 146	BAYCLIFF, TX 77518
BAYGAS	2694 CALDER DR	LEAGUE CITY, TX 77573
BAYGAS	12521 HWY 6	SANTA FE, TX 77510
BAYSIDE RV PARK	5437 FM 646	BACLIFF, TX 77518
HOP'S PROPANE & PERFORMANCE	16103 HWY 6	SANTA FE, TX 77517
PALMER AVE EXXON	3520 PALMER AVE	TEXAS CITY, TX 77590
RAINEY POOL CO	1101 GULF FRWY	LEAGUE CITY, TX 77573
	LIBERTY COUNTY	
ALFORD LP GAS CO	2221 HWY 770 N	HULL, TX 77564
ARCTIC GAS	24523 HWY 321	CLEVELAND, TX 77327
BIG THICKET LP GAS CO	BIG THICKET LAKE ESTATES	RYE, TX 77369
FERGUSON PROPANE	510 RAYBURN ST	CLEVELAND, TX 77327
STANFIELD PROPANE	388 FM 2025	CLEVELAND, TX 77327
T NEALE PROPANE	712 W CLAYTON	DAYTON, TX 77535
WILLIAMSON LP GAS CO	3337 FM 1960	DAYTON, TX 77535
	MONTGOMERY COUNTY	
A & D PROPANE	14366 FM 1314	CONROE, TX 77302
AMERIGAS PROPANE	1376 BEACH AIRPORT RD	CONROE, TX
AUTOMATIC GAS	813 S FRAZIER	CONROE, TX 77301
CWS PROPANE	415 S FRAZIER	CONROE, TX 77301
BUSTER BROWN PROPANE	20126 LOOP 494	NEW CANEY, TX 77357
HUGHES LP GAS	31830 HWY 249	PINEHURST, TX 77362
INDEPENDENT PROPANE	10070 FM 1097 W	WILLIS, TX 77378
CWS PROPANE	24624 HWY 59	PORTER, TX
FLYING J TRUCK STOP	IH-59 & EXIT 242	NEW CANEY, TX 77357
	WALLER COUNTY	
LOCAL LP GAS CO	34227 IH-10	BROOKSHIRE, TX 77423
AMERIGAS PROPANE	3014 TAYLOR ST	WALLER, TX 77484
WALLER COUNTY BUTANE CO	3015 WALLER ST	WALLER, TX 77484
FLYING J TRUCK STOP	IH-10 EXIT 732	BROOKSHIRE, TX 77243

Table C-7. Propane Retailers by County for BPA

Company	Street Address	City, State Zip
	HARDIN COUNTY	
CANNON'S PROPANE CO	2063 FM 92	SILSBEE, TX 77656
SILSBEE PROPANE FUELS	811 N 5TH ST	SILSBEE, TX 77656
TREST LP GAS CO	410 S MAIN ST	LUMBERTON, TX 77657
	ORANGE COUNTY	
FLYING J TRUCK STOP	7112 IH-10 W	ORANGE, TX 77632
MIKE'S HANDY HARDWARE	2800 N MAIN	VIDOR, TX 77662
PROGAS/INERGY PROPANE	890 W FRWY BLVD S	VIDOR, TX 77670
	JEFFERSON COUNTY	
A-1 RENTAL	3249 25TH ST	PORT ARTHUR, TX 77642
MADDOX PROPANE	16181 HWY 124	BEAUMONT, TX 77705
PORT HARDWARE	6105 W PORT ARTHUR RD	PORT ARTHUR, TX 77640
SANDIFER'S LP GAS CO	5812 GULFWAY DR	PORT ARTHUR, TX 77643
YOUNG'S	1219 MAGNOLIA	PORT NECHES, TX 77651

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APPENDIX D: ALTERNATIVE FUEL SCHOOL BUSES IN TEXAS – 2009

Metropolitan Area	County Name	School District	Number of Buses	County Totals
Houston	Brazoria	Alvin ISD	107	107
DFW	Collin	Prosper ISD	32	32
DFW	Dallas	Carrollton	2	
DFW	Dallas	Coppell ISD	2	
DFW	Dallas	Dallas County Schools	589	
DFW	Dallas	Duncanville ISD	1	594
DFW	Denton	Denton ISD	115	
DFW	Denton	Texas Women's University	14	129
DFW	Ellis	Midlothian ISD	6	6
Houston	Harris	La Porte ISD	9	
Houston	Harris	Texas Women's University	1	10
Beaumont	Jefferson	Lumberton ISD	3	3
DFW	Tarrant	Azle ISD	6	
DFW	Tarrant	Dallas County Schools	3	
DFW	Tarrant	Ft. Worth Transport. Auth.	1	
DFW	Tarrant	Mansfield ISD	11	21

SOURCE: Texas Railroad Commission.

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